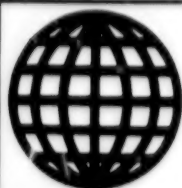


JPRS-UEE-89-006  
31 JULY 1989



**FOREIGN  
BROADCAST  
INFORMATION  
SERVICE**

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# ***JPRS Report***

# **Science & Technology**

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***USSR: Electronics &  
Electrical Engineering***

# Science & Technology

## USSR: Electronics and Electrical Engineering

JPRS-UEE-89-006

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UDC 621.397.611

**Outlook for Use of Magnetic Tapes for Recording Audio-Visual Information in Cinematography**

18600001a Moscow *TEKHNICA KINO* 1

*TELEVIDENIYA* in Russian No 8, Aug 88 pp 6-10

[Article by G. I. Loznevoy and A. V. Varlamov, Leningrad Institute of Motion Picture Engineers]

[Abstract] Magnetic recording of both audio and video signals offers the motion picture industry many advantages over their optical recording. The advantages of magnetic sound recording are high fidelity, long life of tapes, low cost, and insensitivity to light, simpler processing without photochemical treatment and consequently with simpler equipment, also the possibility of in-processing or immediate post-processing inspection. Image recording requires a wide frequency range, very short recording wavelengths, and "from saturation to saturation" magnetization as well as very high velocity of the information carrier relative to the information pickup. Magnetic image recording meets these requirements and, in addition, offers the possibility of immediate and repeated scanning of frames for inspection as well as playback and optimal dubbing or rerecording. Other advantages of magnetic audio and video recording are the possibility of simultaneous shooting from several points with mixer transfer from one camera to another, the possibility of applying television techniques of composite shooting, and the possibility of following an episode through without interruptions. The major problems in magnetic sound tracking are technological ones, namely long time lapse from preparation and deposition of a magnetic suspension, imprecise deposition of magnetic tracks on film, warping of the latter caused by their nonuniform width and thickness as well as by their surface roughness, also unreliable contact between magnetic head and surface of magnetic tracks owing to thick and rigid film substrate (cellulose triacetate). These problems are surmountable so that magnetic tape will become more competitive for use in audio and video recording. References 21: 20 Russian, 1 Western.

UDC 621.397.13.62.001.7(100)

**Outlook for Television in Next 15 Years: Based on SMPTE Journal**

18600001c Moscow *TEKHNICA KINO* 1

*TELEVIDENIYA* in Russian No 8, Aug 88 pp 25-28

[Article by A. Ya. Khesin and T. P. Nesmelova]

[Abstract] The article is a condensed translation of "New Frontiers: The Next 15 Years" in the SMPTE Journal's Vol 96, Nov 1987 issue. First are summarized developments in the past 15 years of television, the viewers' concerns, and the American engineers' system approach to television program production and transmission. Projections are then made for the next 15 years, among them further development of high-definition television and

extended use of satellite communications systems. Another important trend are developments in both magnetic and optical recording of audio and video signals, with use of semiconductor memories ensuring an infinitely long life without moving parts, and conversion from the 25.4 mm format to a 12.7 mm format followed by conversion to a 6.3 mm format with attendant development of appropriate universal audio-video tape recorders. A not less important trend is toward computer-aided optimization of studio equipment performance including flexibility and of program production and transmission including automatic and thus more productive recording. Projections for the next 15 years take into account anticipated technological progress and likely changes in the television industry such as conversion to analog techniques in a few areas and to digital techniques in most areas, universal use of charge-coupled devices in television cameras improvement of broadband direct television broadcasting, extended use of fiber optics in cable television systems, and properly timed standardization: not too soon so as not to discourage new developments and not too late so as to avoid the need for tradeoffs resulting in a less than optimum standard. These projections are based largely on information about the state of the art at the National Broadcasting Company. References 1: Western.

UDC 621.397.6

**Design Features of High-Definition Television System**

18600001d Moscow *TEKHNICA KINO* 1

*TELEVIDENIYA* in Russian No 8, Aug 88 pp 62-65

[Article by F. V. Samoylov]

[Abstract] A comparative design and performance evaluation covering three variants of an NTSC-to-HDTV signal converter and two variants of an HDTV-to-NTSC signal converter is made on the basis of data pertaining to HDTV systems demonstrated by American, Swiss, Japanese, and other firms at the April 1988 International Exposition in Las Vegas, Nevada. The most important special effects facilitating composition of original video programs and video clippings in an HDTV standard are: image compression and expansion in any direction, insertion and withdrawal of moving slides and stationary picture, breakup of image into mosaical polyimages, frame stop for focus translocation toward magnification or reduction, selective and multiple stop of any image segment, arbitrary change of horizontal and vertical image dimensions, arbitrary change of image background arbitrary change of image edges, insertion and withdrawal of image along any trajectory or wedgewise, momentary appearance and disappearance of image. Besides the signal converters, other important components of an HDTV system include a studio commutator of  $Y, P_B, P_R$  signal components and a mixer-amplifier.

According to the NHK of Japan, its chronology of HDTV development begins with inception in 1975 and ends with completion in 1990. Figures 10; tables 4; references 1: Western.

**Provisions for Development of Radio Communication Systems Contained in Resolutions of C.C.I.R.'s 16th Plenary Assembly**

18600073a Moscow ELEKTROSVYAZ in Russian  
No 8, Aug 88 (manuscript received 20 Jun 87) pp 8-10

[Article by R. Kirby, director, and A. B. Nalbandyan, counsellor, CCIR]

[Abstract] The 16th plenary CCIR assembly held in May 1986 in Dubrovnik (Yugoslavia) approved 160 recommendations, including new ones and revised older ones. It also resolved to retain the organizational structure as well as the names and the mandates of its 13 research commissions, two of them operating jointly with CCITT commissions. These research commissions had recommended further improvement of mobile maritime and satellite radio communication services as well as ground and satellite radio relay systems. Other recommendations contain supplementary specifications and revisions of old ones regarding radio wave propagation and television broadcasting, to match latest trends and new techniques such as sharing of radio channels and digital transmission of images aimed at improvement of program transmission quality and management. Tables 1.

UDC 621.396.946.2

**Harmonization of Fixed-Satellite-Service Networks**

18600073b Moscow ELEKTROSVYAZ in Russian  
No 8, Aug 88 (manuscript received 29 Apr 88) pp 11-15

[Article by S. V. Borodich]

[Abstract] Coordination and planning of fixed-satellite-service networks is considered, a method of harmonizing a new network being proposed which will ensure its compatibility with others in terms of crosstalk immunity and thus contribute to more efficient use of a geostationary orbit. The method is designed for the general case of networks with not necessarily the same degree of interference immunity and satellites not necessarily spaced for maximum angular diversity. Its algorithm involves essentially calculation of signal-to-noise and signal-to-interference ratios as functions of network parameters and ensuring that these ratios do not fall below acceptable minimum levels. For harmonization during coordination of two networks, all parameters of the first network are assumed to be known and to remain invariable. The territory of the second network and its location relative to the corresponding territory of the first one are arbitrarily specified, both transmitter and receiver gains in the second network at the edge of its territory as well as within the territory of the first network thus becoming

also known quantities. Different assumptions are made and the algorithm is appropriately modified for harmonization during planning of new networks. Tables 2; references 2: Russian.

UDC 621.391.15

**Selection of Input Parameters for Planning Use of Geostationary Orbit for Fixed Satellite Service**

18600073c Moscow ELEKTROSVYAZ in Russian  
No 8, Aug 88 (manuscript received 7 May 88) pp 16-20

[Article by L. Ya. Kantor]

[Abstract] Planning the use of a geostationary orbit for fixed satellite radio-broadcasting service is discussed, the universally accepted assumption being that the antennas of ground stations in all zones have the same diameter. The same radiation power density is therefore guaranteed at the edges of all zones, inasmuch as the signal-to-noise ratio and the integral noise temperature at the receiver input are also approximately the same in all ground stations, while the transmitters of all space stations emit radiation power whose isotropic equivalent is the same. On the basis of these assumptions and taking into consideration the economic constraints on the design of real satellite communication systems, the selection of input parameters for planning the use of a geostationary orbit in accordance with the principle of equal channel capacities and particularly for planning an uplink for radio broadcasting in the 12 GHz frequency band. Figures 3; references 5: 3 Russian, 2 Western.

UDC 621.315.2

**Maritime and Transoceanic Underwater Optical-Fiber Cables**

18600073d Moscow ELEKTROSVYAZ in Russian  
No 8, Aug 88 (manuscript received 14 Dec 87) pp 26-30

[Article by D. L. Sharle]

[Abstract] Design and performance of underwater optical-fiber cables for maritime and transoceanic communication systems are analyzed, taking into consideration the extra requirements in addition to those also applicable to electrical cables. These special requirements are complete sealing of fibers against not only water but also free hydrogen and avoidance of excessive stretching so as to prevent excessive attenuation as well as corrosion and mechanical aging. Structural and operating characteristics of such cables, deep-water cables constituting a special class, are reported on the basis of manufacturers' and service data made available by Western sources. Figures 6; tables 2; references 8: 1 Russian, 7 Western.

UDC 621.396.97

### Construction of Digital Radio Broadcasting Network

18600080d Moscow ELEKTROSVYAZ in Russian  
No 9, Sep 88 (manuscript received 8 Apr 87) p 25-26

[Article by V. M. Kolesnikov and M. U. Bank]

[Abstract] Construction of a digital radio broadcasting network serving digital home radio receivers built with large-scale-integrated circuit chips is proposed, seven possible variants being considered which completely cover the assigned territorial zones without shadows and two of which are found to be most promising. These two are a one-frequency network and a multifrequency network with compression of the digital signal in each. Compression reduces the rate at which the digital flux of monophonic programs as well as symbols of the interference-immune code are transmitted to 192 kbit/s, the information rate being only 150 kbit. The advantages of the first variant are all those of digital systems and, moreover, compatibility with likely future other digital transmission systems such as satellite cable systems requiring only attachment of a converter to the home radio receiver. The advantages of the second variant are its easy realization in terms of network technology and easy gradual transition from analog to digital broadcasting, inasmuch as any one program occupies the same frequency band in VHF FM and DRB (digital radio broadcasting) channels. These two variants are preferable to one-frequency, three-frequency, and multifrequency networks without compression of the digital sound signal, to a one-frequency network with a multifrequency modem and with sound signal compression, and to a three-frequency network with subcarriers and with sound signal compression. References 1: Russian.

### On Ways To Increase Efficiency of Short-Wave Radio Broadcasting

18600080e Moscow ELEKTROSVYAZ in Russian  
No 9, Sep 88 (manuscript received 16 Feb 88) pp 32-33

[Article by Yu. A. Chernov]

[Abstract] Ways of achieving high-efficiency short-wave radio broadcasting are comparatively evaluated, considering coverage of a contiguous low-elevation azimuthally wide-angle territory and of a remote low-elevation azimuthally small-angle territory. In the first case a second radio station is added which operates at a frequency ensuring high reliability in the far field, while the first radio station operates at a frequency ensuring high reliability in the near field, or both radio stations operating as a synchronous pair with second radio station far removed from the first one and away from the covered territory. In the second case it is expedient to use an antenna with the major lobe of the radiation pattern as wide as the covered territory, but one transmitter or three transmitters must often be added to boost the power with either all transmitters feeding a common

antenna or all transmitters spaced far apart operating either at different frequencies or in synchronism. Figures 1; references 2: 1 Russian, 2 Western (WARC-HFBC-87).

UDC 621.396.97

### Encoding High-Quality Sound Signals in Frequency Domain

18600080f Moscow ELEKTROSVYAZ in Russian  
No 9, Sep 88 (manuscript received 9 Apr 87) pp 34-36

[Article by M. N. Moiseyev and A. M. Sinilnikov]

[Abstract] Orthogonal transformation of sound signals into the frequency domain is evaluated in terms of adaptation to the response characteristics of the ear with minimum distortion, the ear being essentially a frequency analyzer and high-fidelity sound reproduction requiring a sufficiently low transmission rate not readily attainable by dynamic predistortion in differential-pulse-code-modulation systems. The discrete cosine transform is shown to be the most desirable of all known orthogonal transforms, owing to its highest concentration of energy in relatively few coefficients. Encoding the coefficients of this transform means masking the tones within one frequency group and masking the distortions of spectral components, inasmuch as the ear will integrate the signal energy within a certain frequency band called frequency group. The amplitude spectrum of a typical sound signal demonstrating the principle of such an encoding indicates that the weaker a spectral component is, the less perceptible will be its suppression. Therefore, only the strongest spectral component within a relatively narrow frequency range approximately as wide as a frequency group needs to be encoded with the highest possible precision. High encoding precision is, however, required within all frequency groups which contain the strongest spectral components. The encoding algorithm based on these considerations yields a sequence of binary digits representing the characteristics and the mantissas of the transform coefficients. This encoding algorithm and subsequent decoding were tested by taping band music, symphonic music, and piano solo music with an MX-80 digital magnetic studio recorder. A transmission speed as low as 111 kbit/s with a compression factor correspondingly as high as 7 were found to be attainable and to yield an excellent quality of sound reproduction, according to the results of subjective-statistical evaluation of expert listeners' perception. Figures 2; references 7: 2 Russian, 5 Western.

UDC 621.317.3:621.396.97

### New Measuring Instruments for Wire Broadcasting Networks

18600080g Moscow ELEKTROSVYAZ in Russian  
No 9, Sep 88 (manuscript received 14 Oct 87) pp 37-40

[Article by P. Ya. Dubult, I. I. Avdeyev, G. A. Afanasyev, and A. N. Mikheyev]

[Abstract] Three new measuring instruments have been developed and built at the Scientific Research Institute



of Radio Broadcast Reception and Acoustics, specifically for in-production and in-service quality control of equipment designed to operate in wire broadcast channels carrying three programs. These instruments are the KPU-2 semiautomatic multifunctional monitoring receiver, with the MP-2 monitor attachment forming AM test signals on a 78 kHz or 120 kHz carrier, the IMTsV small portable battery-powered universal line maintenance voltmeter, and the UPPP crosstalk and fault finder. Figures 4; tables 4; references 8: Russian.

**Soviet-French Seminar on Problems in Development of Optical-Fiber and Digital Transmission Systems**

*18600080h Moscow ELEKTROSVYAZ in Russian  
No 9, Sep 88 p 45*

[Article by I. Valentinova]

[Abstract] In the Soviet-French seminar held in April 1988 in Leningrad on the subject of optical-fiber and digital transmission systems participated representatives of the USSR Ministry of Communications, the USSR Ministry of Communication Equipment Industry, and the USSR Ministry of Electrotechnical Industry. On the French side were representatives of SAT, Alcatel-CIT, Radial, and the Administration of Communications in France. The topics of 25 papers and their discussion

covered technical and commercial aspects of producing such transmission systems. Those presented by the Soviet specialists dealt with organization of rural digital telephone distribution networks into a ring configuration of the line channel, transmission of sound broadcasting signals in a studio format over the H-12 channel, automatic maintenance of local urban telephone networks, setting norms for errors in digital channels, estimating the effect of pulse interference in pulse-code-modulation audio-frequency channels, and time grouping of channels in accordance with CCITT recommendations G.745/753/754, also with construction of the 7680-channel high-speed optical-fiber transmission system in the USSR, cumulative estimation of the interference immunity of optical-fiber transmission systems and of the sensitivity of optical receivers, development of commutators for switching optical channels, and development of magnetooptic nonreciprocal devices for decoupling optical-fiber transmission channels. Most interesting were the papers on optical-fiber cables for video telephone communication and for television broadcasting, on construction of multistation-access radio links for rural communication networks, and development of universal optical connectors. Commercial aspects were covered by the French specialists, confirming the advantages of digital over analog transmission and of optical over electrical cables in a fully digitalized communication network.

UDC 621.371

### Fluctuations of Field Interference Pattern Near Skip Distance

18600032b Gorkiy IZVESTIYA VYSSHIKH  
UCHEBNIKH ZAVEDENIY: RADIOFIZIKA in  
Russian Vol 31 No 6, Jun 88 (manuscript received  
25 Jul 86) pp 660-668

[Article by P. V. Bliokh, V. G. Galushko, A. A. Minakov,  
and Yu. M. Yampolskiy, Institute of Radio Astronomy,  
USSR Academy of Sciences]

[Abstract] The field interference pattern near the skip distance for short radio waves is analyzed, considering that the wide fluctuations of signal level occurring there are highly sensitive to the state of the ionosphere. Calculations are based on a parabolic model of the ionospheric layer whose initial altitude and critical frequency vary in time. Both ionosphere parameters are determined on the basis of their relation to two quantities measurable with a radio telescope, namely angle of arrival of the lowerwave and phase-path difference between lower and upper waves. The two equations relating these two measurable quantities to the two ionosphere parameters have been solved by numerical methods, disregarding horizontal gradients in the ionosphere and gradients of the geomagnetic field. The half-thickness of the ionospheric layer is assumed to be known, approximately 100 km, inasmuch as it can be predicted quite accurately and because it undergoes practically no diurnal variations within the Temperate Zone. Fluctuations of the field interference pattern are in turn determined by the statistical characteristics of those two measurable quantities and, accordingly, data based on calculations including statistical analysis are correlated with results of measurements made within the 10-15 MHz frequency band with an UTR-2 decametric telescope including a highly directional antenna and covering a short single-span range, for a determination of the ionosphere nonhomogeneity parameters including its characteristic distance. The error of theoretical estimates is found not to exceed a few kilometers. The authors thank V. S. Beley for assisting in measurements. Figures 6; references 14: 13 Russian, 1 Western (in Russian translation).

### Method of Calibrating a Matched Shielded Loop Antenna

18600170d Kiev TEKHNIЧЕСКАЯ  
ELEKTRODINAMIKA in Russian  
No 1, Jan 89, pp 60-62

[Article by L. V. Vasenkov]

[Abstract] In order to avoid the difficulties involved in the calibration and testing of magnetic field strength meters such as direct antenna current measurements this article proposes a matched shielded loop antenna to allow direct voltage measurements from a variable RF

oscillator or to set the output voltage from a programmable RF calibrator; this technique also makes it possible to automate the magnetic field reproduction process. This shielded loop antenna represents a matched load for the oscillator. The measured frequency progression of the calibration coefficient of the shielded loop antenna in the 10 kHz-30 MHz range is 5.6 percent and is identical to the calculated frequency progression of this coefficient within measurement error. Such a shielded loop antenna can be used to develop broadband standards for reproducing magnetic field strength levels with a broad dynamic range; the field strength recovery process can be entirely automated or can be implemented in an oscillate sweep mode.

UDC 621.391.01

### Optimization of Two-Dimensional Aperture Synthesizing Systems

18600079c Moscow RADIOTEKHNIKA I  
ELEKTRONIKA in Russian Vol 33 No 9, Sep 88  
(manuscript received 30 Mar 87) pp 1918-1922

[Article by L. Ye. Kopilovich]

[Abstract] An approach to construction of regular two-dimensional aperture synthesizing systems more effective than T-systems and to optimization of their geometry for minimum redundancy is proposed, namely multiplication of linear systems and use of difference sets. The general procedure involves construction of a denumerable wavelength-scale grid in the aperture and excerpction of an auxiliary rectangular or in the special case square set which uniformly and densely covers the given range of space frequencies in both directions with the minimum number of receiver elements. The basis for such a set can be obtained by multiplying the one-dimensional bases of its sides. Such one-dimensional bases with minimum or nearly minimum redundancy have been obtained simply for sets of not more than 19 denumerable points and can be obtained for sets of more than 19 denumerable points by use of cyclic difference sets. Bases obtained by multiplication of one-dimensional ones are essentially "degenerate," but this method can be extended to use of two-dimensional difference sets for construction of aperture synthesizing systems with a large number of receiver elements approaching the optimum number. The author thanks L. G. Sodin for discussion and helpful comments. Figures 3; tables 3; references 12: 5 Russian, 7 Western (1 in Russian translation).

UDC 537.874.6.01

### Near Field Characterizing Diffraction of Plane Wave by Periodic Grating of Coaxial Metal-Dielectric Cylinders

18600079e Moscow RADIOTEKHNIKA I  
ELEKTRONIKA in Russian Vol 33 No 9, Sep 88  
(manuscript received 17 Nov 86) pp 1985-1987

[Article by F. G. Bogdanov, G. Sh. Kevanishvili, Z. I. Sigmashvili, O. P. Tsagareyshvili, and M. N. Chikh-ladze]

[Abstract] Diffraction of an E-polarized electromagnetic wave by a parallel grating of identical coaxial metal-

dielectric cylinders is considered, the entire resultant field in space being completely determined by its electric component expandable into two infinite series in Hankel functions for the incident wave and in Bessel functions plus Neumann functions for the scattered field respectively. Analysis of the near field indicates a strong distortion of the amplitude-phase distribution across the grating as well as in the direction of the incident wave, the electric field concentrating within the dielectric layer and being expelled from the metal layers so that a large field gradient appears at the conducting metal surface. The magnitude of the field jump becomes larger and the focusing action of the grating becomes stronger, as the dielectric-to-metal volume ratio is increased. Figures 2; references 3: 2 Russian, 1 Western (in Russian translation).

**Electromagnetic Wave Scattering by Bounded Grating Strips with Random Fluctuations in Element Spacing**

18600178a *RADIOTEKHNIKA I ELEKTRONIKA* in Russian Vol 34, No 3, Mar 89, pp 449-458

[Article by S. N. Vorobev, E. V. Zamyatin, and S. L. Prosvirnin]

[Abstract] This article carries out an analysis of the fundamental statistical characteristics of electromagnetic wave scattering by bounded grating strips whose elements experience random spacing fluctuations within the plane of the array. The array under analysis is formed by a finite number of thin, ideally-conducting strips with random spacing. This structure represents an adequate mathematical model of actual strip arrays and, second, the finite dimensions combined with the nonequidistant spacing configuration makes it possible to analyze physical effects associated with the boundedness of the structure. The analysis of this structure did not reveal any significant differences in the statistical characteristics of the RF fields with uniform and Gaussian distributions of the spacing fluctuations. Ultimate fluctuation levels were established, i.e., levels above which the array is no longer considered an ordered structure, which causes qualitative changes in the statistical characteristics. The radiation amplitude in the array plane rises significantly when fluctuations in element spacing are present; such amplitude is dependent on the angle of incidence of the excitation wave. It is also determined that the diffraction rays corresponding to the harmonics of the field scattered by an equivalent periodic array are much more sensitive to changes in the spacing fluctuations than is the fundamental wave. The angle of inclination of the strips and the angle of incidence of the wave have virtually no influence on the dependence of the harmonic amplitudes on spacing fluctuations.

**Structure and Qualitative Spectral Composition of Waves Reflected off a Rotating Strip**

18600178c *RADIOTEKHNIKA I ELEKTRONIKA* in Russian Vol 34, No 3, Mar 89 pp 485-493

[Article by E. Z. Gribova]

[Abstract] This study carries out a comparative analysis of plane electromagnetic wave diffraction by a rotating, ideally conducting and infinitely thin strip. The analysis considers several particular scattering cases for different strip configurations, point of observation, and wave vectors of the incident wave. The analyzed cases include TE-wave incidence, TM-wave incidence, and TE-wave incidence for the receiver located on the x axis and the receiver located on the z axis. It is determined that the latter geometry provides the most comprehensive representation of effects that occur from plane monochromatic wave diffraction by a rotating strip: the changes in the field structure are most clearly reflected in this configuration, since it is very nearly always depolarized; moreover, severe changes in spectral composition due to the Doppler effect and amplitude-phase modulation caused by rotation are present. It is also determined that an number of qualitatively new effects that are not observed from diffraction by a fixed strip appear in this context.

**Transparency of a Dense Grating of Parallel Overlapping Metallic Strips Separated by a Dielectric Layer**

18600178d *RADIOTEKHNIKA I ELEKTRONIKA* in Russian Vol 34, No 3, Mar 89, pp 499-504

[Article by I. G. Alekseev, V. I. Felyanovich, and Yu. A. Shestakov]

[Abstract] This study solves the problem of establishing low capacitive transparency by using surfaces consisting of parallel, partially-overlapping metallic strips separated by a dielectric layer. The length of the dielectric channel between the centers of the half-slits is varied by altering strip overlapping. Two experiments were carried out for  $H_{10}$  mode in a rectangular waveguide. Ten specimens were used for the first experiment; these specimens were diaphragms consisting of two overlapping metallic strips separated by a dielectric. They were fabricated from FAF-4D fluoroplast strips with a .05 mm metallic coating on each side. The specimens had a different parameter  $\chi$  characterizing the overlapping between plates. Analogous diaphragms were fabricated for the second experiment; the only difference in this case was that a grating period of 1.5 instead of .5 was used. The grating under analysis, which is continuous in x, is not recommended as a capacitive weakly-transparent sheet for an antenna in which  $H_z$  is not equal to zero. The eddy currents arising in this structure produce additional losses and their reactance serves to increase strip overlapping and reduce the antenna broadband

response. The analysis reveals that the preferred design is a grating with periodically irregular strips in which the eddy currents are significantly reduced.

**Signal Detection in Spatially-Inhomogeneous Interference Conditions**

18600178e *RADIOTEKHNIKA I ELEKTRONIKA* in Russian Vol 34, No 3, Mar 89, pp 545-550

[Article by V. M. Koshevoy]

[Abstract] This study derives analytic expressions for calculating signal detection quality factors against a background of spatially-inhomogeneous interference. The study focuses on methods of reducing the influence of spatial inhomogeneity of interference on detection

efficiency and it is determined that knowledge of the nature of the noise distribution inhomogeneity in the irradiation channels makes it possible to improve normalization effectiveness. Therefore the possibility for improving normalization derives directly from estimates of the nature of the inhomogeneity. This suggests that using the structural properties of correlation matrices which provide high normalization effectiveness with small sampling makes it possible to most effectively utilize the stabilizing properties of logic normalization algorithms. The derived relations also make it possible to calculate the signal detection efficiency for various normalization algorithms and various interference inhomogeneities, taking into account, specifically, the interference "edges" as well as the presence of signals in the samples.



**Noncoherent Discriminator Optimization for Pseudonoise Signal Delay Lock Tracking Systems**  
18600163b IZVESTIYA VYSSHIKH UCHEBNIKH  
ZAVEDENIY: RADIOELEKTRONIKA in Russian  
Vol 31, No 11, Nov 88 pp 12-16

[Article by V. P. Ipatov and I. V. Ptsitsyn]

[Abstract] This article performs optimization of a noncoherent discriminator of a delay lock tracking system based on minimum mean square error at the output of the delay lock tracking system for the case where the statistics of the digital data and the input Doppler signal are known. The study demonstrates that the sign of the error signal is independent of the digital data and the Doppler frequency shift of an input signal that does not exceed one half the transmission band of the bandpass filters, which makes such an analysis possible. Equations are derived for achieving an optimum amplitude-frequency response of the bandpass filter in specific operating conditions. Along these lines it is demonstrated that the amplitude-frequency response of the optimum filter is uniform in the band where the majority of signal energy is concentrated with a large equivalent signal-to-noise ratio, while the amplitude-frequency response matches the signal density with a small such signal-to-noise ratio.

**Non-Gaussian Interference Suppression Mechanism in Optimum Nonlinear Weak Signal Detectors**  
18600163c IZVESTIYA VYSSHIKH UCHEBNIKH  
ZAVEDENIY: RADIOELEKTRONIKA in Russian  
Vol 31, No 11, Nov 88 pp 30-34

[Article by A. Ye. Ulanov and G. Ya. Shaydurov]

[Abstract] This study investigates the joint transmission of a signal and Rice interference through a random polygonal nonlinear frequency converter with a random signal-to-interference ratio that is not necessarily small. The effectiveness of the nonlinear processing routine is estimated by the energy quality factor accounting for the fine spectral structure of the nonlinearly-transformed process. The analysis indicates that the nonlinear processing efficiency drops with increasing signal amplitude and is accompanied by additional degradation of the output signal-to-noise ratio. When the input signal level remains low, yet comparable to the input interference level, the non-Gaussian component will be suppressed in certain specific conditions. Moreover, the mutual modulation effect in this case will address new terms to the intermodulation spectrum with power levels comparable to the fundamental beating products.

**Analysis of Quasioptimum Decoding Algorithms for Biorthogonal Codes**  
18600163d IZVESTIYA VYSSHIKH UCHEBNIKH  
ZAVEDENIY: RADIOELEKTRONIKA in Russian  
Vol 31, No 11, Nov 88 pp 47-51

[Article by A. Ye. Ashikhmin, S. N. Litsyn]

[Abstract] This article derives noise-immunity estimates for quasioptimum biorthogonal code decoding algorithms that function by eliminating one of two hypotheses in each algorithm step, such a process being determined from a comparison of two sums of the moduli of the vector elements of a certain step of an abbreviated fast Walsh-Hadamard transform. The study also carries out an asymptotic analysis of erroneous decoding estimates. The analysis makes it possible to obtain an estimate of the error probabilities of both analyzed decoding algorithms. The analysis reveals that the error probability in the  $j$ th step of the algorithm diminishes with increasing  $\beta$ . A comparison of subsequent estimates shows that the decoding algorithms involving a rejection of hypotheses are asymptotically optimum, although the decoding error probability for comparing the moduli sums vanishes more rapidly when comparing the squared sums.

**Estimate-Correlation Detection Algorithm for Complex Signals with Variable RF Channel Noise Intensity**  
18600163f IZVESTIYA VYSSHIKH UCHEBNIKH  
ZAVEDENIY: RADIOELEKTRONIKA in Russian  
Vol 31, No 11, Nov 88 pp 55-57

[Article by S. Ye. Adadurov, A. A. Kozlov, and I. Yu. Lyutynskiy]

[Abstract] This study considers issues associated with the modernization of complex signal detection systems operating in conditions of variable RF channel noise intensity. The analysis focuses on possible improvements to detection performance based on estimate-correlation algorithms. The study establishes the detection characteristics for detecting a complex PSK signal for an estimate correlation detector with the estimation device in the form of a Kalman filter and a filter of random structure determined by the relations provided in the study for the case where noise intensity increases at times corresponding to one half and one quarter the total analysis time of an elementary cell of the signal parameter uncertainty range. It is determined that the detection properties for an estimate-correlation detector with an estimation unit containing a filter of random structure are superior to those of an estimation unit employing a Kalman filter. The proposed modification of estimate-correlation reception algorithms is demonstrated to substantially improve complex signal detection characteristics.

**Amplifier-Attenuator Based on a Microprocessor-Controlled Two-Gate Field-Effect Transistor**

18600163g IZVESTIYA VYSSHIKH UCHEBNIKH  
ZAVEDENIY: RADIOELEKTRONIKA in Russian  
Vol 31 No 11, Nov 88 pp 56-66

[Article by N. N. Fomin and V. V. Frik]

[Abstract] This article focuses on the microprocessor control techniques for an amplifier-attenuator based on a two-gate field-effect transistor. The microprocessor control system described can be used to synthesize and to easily adjust a wide variety of rather complex characteristics of the amplifier-attenuator. If the provided functional relation is known it is possible to obtain necessary control code tables for the device. By employing a cascade configuration of several such devices under parallel control it is possible to significantly improve the gain and attenuation characteristics, while series-manufactured microwave two-gate FETs can be used to implement such devices at frequencies up to 12 GHz. The article claims that replacing the comparatively cumbersome microprocessor set with a single-chip microcomputer (such as the K1816) will substantially improve the size and weight properties of the overall system in the future.

**Luminescence Nonlinearity of GaInAsP/InP Heterostructures in the 1.0-1.6  $\mu\text{m}$  Range**

18600178h RADIOTEKHNIKA I ELEKTRONIKA in  
Russian Vol 34, No 3, Mar 89, pp 618-627

[Article by P. G. Elishev and I. S. Tsimberova]

[Abstract] This study carries out a calculation and analysis of the I-P characteristic and nonlinear distortion levels based on the recombination balance in the active region of quaternary radiating GaInAsP/InP heterostructures in the 1.06-1.55  $\mu\text{m}$  range. Radiating twin heterostructures fabricated by liquid-phase epitaxy onto InPn-type substrates were employed as the test specimens. The dopants included Te as the donor and Zn, Mn, or Mg as the acceptor. The active layer of the quaternary composition was 0.5-3  $\mu\text{m}$  thick with the p-emitter running at 4-8  $\mu\text{m}$  thick. Circular mesa-structure specimens were used in the measurements. The radiation was extracted through the substrate horizontally (normally 200  $\mu\text{m}$  thick). Wafer dimensions were 750 by 750  $\mu\text{m}$  and the mesa diameter was 40, 100, and 180  $\mu\text{m}$ . Tests on these specimens indicate that radiating structures based on this quaternary system have a dynamic operating range at the operational current levels of the diodes. The dynamic operating range of the diode will depend on the radiation wavelength: for long-wavelength diodes it is narrower and shifted towards lower pump currents. Calculation indicates that nonlinear distortions are minimized at a current density of 250 to 300  $\text{angstroms per cm}^2$  in structures with an average external quantum efficiency of approximately 2 percent at a radiation wavelength of 1.55  $\mu\text{m}$ . The paper also provides the P(I) and F(I) relations for these specimens. Both relations are measured for a mesa diode

radiating at 1.5  $\mu\text{m}$  with a mesa diameter of 40  $\mu\text{m}$ . The graphs indicate that the P(I) and F(I) relations are consistent with calculation at both medium and high excitation levels. The overall analysis employing the recombination balance coefficients determined for three active medium compositions at 1.06, 1.3, and 1.5  $\mu\text{m}$  yields a satisfactory agreement with experimental data at both moderate and high excitation levels and makes it possible to calculate the primary parameters and characteristics of radiating diodes.

**Acoustooptic Frequency Demodulator**

18600178i RADIOTEKHNIKA I ELEKTRONIKA in  
Russian Vol 34, No 3, Mar 89 pp 628-631

[Article by N. S. Vernigorov and A. V. Pugovkin]

[Abstract] This study carries out an analysis of an acoustooptic frequency demodulator based on an optical processor with a near-rectangular spectral window function. The special feature of this design, which guarantees linearity of the detector characteristic, is the intensity distribution of the electromagnetic field incident on the acoustooptic modulator. This distribution is near  $r(x)$  equals  $\sin x/x$ . An experimental analysis of this acoustooptic frequency demodulator was carried out using an LGN-105 laser producing a power level of 2 mW with the acoustooptic modulator diffraction efficiency between 5 and 8 percent. The diffracted light signal was recorded by a pin photodiode connected to a broadband video amplifier. The measurements were carried out at a central frequency of 363 MHz. Tests revealed that the optical spatial filtering circuit with a near-rectangular filter characteristic, when used in conjunction with a photodetector, can be employed to develop an acoustooptic frequency detector capable of functioning over a broad frequency range.

**The Correlation of Probability Distributions and the Intensity of Natural Radio Noise Spikes**

18600178j RADIOTEKHNIKA I ELEKTRONIKA in  
Russian Vol 34 No 3, Mar 89, pp 636-640

[Article by V. V. Kabanov]

[Abstract] This study attempts to establish the correlation of the probability distribution and the intensity of natural radio noise spikes by representing atmospheric radio noise as a normal process with a randomly varying dispersion and determining the relation between its probability density and the intensity of signal envelope spikes. The analysis is carried out for analyzing broad band random natural electromagnetic fields in the VLF and SLF frequency bands. The study also proposes a method of determining W(E) and the characteristics of an optimum broadband receiver based on ICCR data on the territorial distribution of atmospheric noise for narrowband signal reception. The study concluded that representing natural radio noise as a random process with a time-dependent dispersion can be used both in the case of narrowband and broadband signal reception. It is also determined that the noise probability density is easily calculated from the dependence of noise spike intensity on the field level. This calculation technique can be used in both the analysis and optimization and methods of signal detection against a background of natural radio noise.

UDC 62-504.6

**Effect of Cross-Coupling Variation on Performance of Electromechanical Space Tracking Systems**

18600007b Novocherkassk IZVESTIYA VYSSHIKH UCHEBNIKH ZAVEDENIY:  
ELEKTROMEKHANIKA in Russian No 6, Jun 88  
(manuscript received 24 Aug 87) pp 76-80

[Article by Valeriy Vladimirovich Grigoryev, candidate of technical sciences, docent, Anatoliy Nikolayevich Korovyakov, candidate of technical sciences, senior scientific associate, and Vadim Rostislavovich Tkachenko, graduate student, Leningrad Institute of Precision Mechanics and Optics]

[Abstract] Two-dimensional discrete electromechanical control systems for space tracking are analyzed for permissible variation of the two cross couplings, such a system including typically two servo drives and thus two inertial channels connected through the common amplifier-converter of the range finder. The analysis by the method of comparison, assuming that the cross-couplings can within the permissible range vary arbitrarily in time, is based on the equations of dynamics with selection of the appropriate Lyapunov function for both servo channels. The general results and calculations for a specific case with identical servo drives indicate that, as the stability of the servo drives increases, the permissible

range of cross-coupling variation widens and this in turn increases the stability of the electromechanical system. As one cross-coupling decreases to zero, the other is allowed to increase infinitely. Figures 2; references 4: Russian.

**Effectiveness of Integrating Navigation Systems at Ground-Based Transport Facilities**

18600163e IZVESTIYA VYSSHIKH UCHEBNIKH ZAVEDENIY: RADIOELEKTRONIKA in Russian  
Vol 31 No 11, Nov 88 pp 55-57

[Article by I. A. Balyakin, I. G. Zagorodniy, S. V. Ozerkovskiy, A. A. Ulybin]

[Abstract] This article focuses on several possible generalizations of a design for integrating an inertial navigation system and a long-range radio navigation system. It is determined that the most obvious improvement is adaptive control with a linearization coefficient in the system equations derived in the study. As the coefficient rises, the duration of transient processes and the dynamic control error drop. However, in order to reduce fluctuation error in steady-state conditions it is necessary to reduce the value of the coefficient. Optimum selection of the coefficient depending on the travel speed and the route irregularity can improve the performance of the integrated expander and, therefore, the control efficiency.

UDC 621.396.96.01

**Characteristics of Radio Detection of Group Target in Randomly Nonhomogeneous Medium**

18600079f Moscow *RADIOTEKHNIKA I ELEKTRONIKA* in Russian Vol 33 No 9, Sep 88 (manuscript received 20 Oct 86) pp 1998-2001

[Article by V. A. Butko and Yu. P. Akulinichev]

[Abstract] Radio detection of a group target which consists of  $N$  individual fluctuating objects is analyzed and an expression for the radar input signal is formulated, assuming that the target cross-section is smaller than the correlation area of the detection field. An analytical expression for the distribution of the complex amplitude of that signal is not feasible, even though the distribution obviously has a circular symmetry and approaches a Gaussian one as the number  $N$  approaches infinity. The detection characteristics, namely dependence of the probability of correct detection on the signal-to-noise ratio and dependence of the threshold signal-to-noise ratio on  $N$  and on the coherence index  $c$ , have therefore been estimated by statistical simulation on a computer with  $N$  varied from 1 to 10 and with  $c^2$  varied from 0 to 40. The results indicate that, as the product  $N \times c$  exceeds 20, detection of such a target in a nonhomogeneous medium does not differ from its detection in free space (infinite  $c$ ) and does not require such a high signal-to-noise ratio as  $N$  becomes larger. Figures 2; references 2; Russian.

**Plane Electromagnetic Wave Scattering by a Severely Prolate Absolutely- Conducting Spheroid**

18600178b *RADIOTEKHNIKA I ELEKTRONIKA* in Russian Vol 34, No 3, Mar 89 pp 458-468

[Article by V. G. Farafonov]

[Abstract] This article This study is devoted to a formulation of the asymptotics of a field scattered by a severely prolate absolutely conducting spheroid for the case where a randomly oriented plane wave is incident on the spheroid. This new solution scheme has a number of advantages over previous techniques that make it possible to solve this problem. First the part of the field corresponding to axisymmetric excitation of the spheroid is isolated and is found in explicit form by means of Abraham potentials. Second, in order to determine the other part of the field new scalar potentials are selected, thereby significantly simplifying the final formulae. Known excitation conditions of a linear antenna are found in the limit process  $b$  tends to 0. Numerical

calculations carried out for  $a/b$  ratios of 10, 50, and 100 (the ratio of the semiminor axis of the spheroid to the semimajor axis) by both exact and approximate algorithms were used to determine the range of applicability of the approximate algorithm. The analysis demonstrates that the scattered field is proportional to  $(b/a)^2$  for a TE wave, while the scattered field is inversely proportional to  $\ln a/b$  for a TM wave in the general case and is of the order of unity if the focal distance of the spheroid is equal to a hole number of half waves.

**Remote Sensing of Agricultural Crops by Picosecond RF Pulses**

18600178f *RADIOTEKHNIKA I ELEKTRONIKA* in Russian Vol 34, No 3, Mar 89 pp 550-556

[Article by V. I. Karpukhin, A. A. Peshkov, and M. I. Finkelshteyn]

[Abstract] This study provides results from ground-based and airborne remote sensing of agricultural crops by picosecond RF pulses. The remote sensing apparatus used in the experiments consists of a transmitter ( $\lambda$  equals 3 cm), a receiver, an antenna array, an instrument section and a recorder. The transmitter produces 100 W 10 GHz pulses 1 ns in duration. The ground-based experiments conducted between 1980 and 1982 on the agricultural crops of the Latvian State Agricultural Academy were intended to determine the relationship between the electrophysical and biometric properties of agricultural crops in natural conditions and to compare these properties to the parameters of the sensing echo signals. Analysis of the ground-based data indicates that the difference in the reflection coefficients for vertical and horizontal polarizations averages less than 2-3 dB and at near-normal angles of incidence the reflection coefficient off the upper edge of the agricultural crops is 5-7 dB below the reflection coefficient off the lower boundary; at angles of incidence of approximately 25 degrees they are approximately equal. The airborne experiments demonstrated that nanosecond RF pulses at 10 GHz for remote sensing of agricultural crops significantly improve the information content of the remote sensing data by separate observation of signals reflected off the crop boundaries. Ground-based and airborne experiments for 45 fields including 12 types of agricultural crops indicate that there is a linear relationship between the difference of the arrival times of the signals and the height of the agricultural crops with a variation factor of less than 10%, which makes it possible to determine the height of agricultural crops with a similar degree of accuracy.



UDC 664.3:538.312

**Use of Electromagnetic Radiation in  
Thermotechnology of Food Production and  
Processing**

18600015 Minsk INZHENERNO-FIZICHESKIY  
ZHURNAL in Russian Vol 55 No 1, Jul 88 (manuscript  
received 5 Mar 87) pp 164-169

[Article by V. V. Krasnikov, Moscow Technological  
Institute of Food Industry]

[Abstract] Research on use of electromagnetic radiation ranging from microwaves to ultraviolet and including solar radiation as source of heat for food production and processing, research done over the past 5-10 years with participation of the Physics Department at the Moscow Technological Institute of the Food Industry, has resulted in several developments which will contribute to conservation of increasingly scarce and costly conventional fuels. These development, of practical and theoretical interest, are: microwave and infrared heating and drying based on principles of heat and mass transfer, resolution of the problem of spectral and integral radiation energy transmission through selectively absorbing and selectively scattering disperse and colloidal-porous media, design of measuring instruments based on

blowup of a thin radiation beam in materials and application of optical methods to nondestructive food inspection, determination of the dependence of optical and thermal radiation characteristics as well as of energy dissipation not only on the consistency of a foodstuff and the a thickness of the processed layer but also on temperature and humidity, determination of the dependence of spectral characteristics of foodstuffs on the wavelength of incident electromagnetic radiation, determination of the laws governing transmission of monochromatic and integral radiation energy through multilayer systems with constant or variable selective optical properties based on solution of pertinent boundary-value problems, generalization of experimental data on moisture distribution and transfer kinetics, and use of microwave power supplies for efficient low-temperature and high-temperature thermotechnological processes with adequate energy dissipation to prevent overheating. An engineering method of designing continuous-duty heat radiation equipment for infrared treatment of food products has been devised, microwave-and infrared bread baking and fruit drying processes have been optimized with construction of microwave-infrared ovens as major objective. Laboratory methods of thermophysical measurements have been devised which involve use of visible or ultraviolet light and include luminescence spectrum analysis, these methods being adaptable for testing solid and liquid foodstuffs from either plant or animal sources.

UDC 621.3.032.269.1.004.6

**Protection of Industrial Electron-Beam Equipment  
Against Breakdowns**

18600002b Moscow ELEKTROTEKHNIKA in Russian  
No 7, Jul 88 (manuscript received 26 Sep 86) pp 31-34

[Article by M. A. Zavyalov, candidate of technical sciences, S. G. Mikhin, candidate of physical and mathematical sciences, V. A. Tarasenkov, engineer, V. A. Khasanov, engineer, and I. G. Khomskiy, candidate of technical sciences, All-Union INstitute of Electrical Engineering imeni V. I. Lenin]

[Abstract] Considering that electron-beam equipment used for technological processes such as vacuum smelting, casting, heat treatment, and coating requires protection against short-circuit in the load during interaction of the electron beam and the treated material, several methods of such a protection are comparatively evaluated following an analysis of the physics of breakdown of the acceleration gap in the electron gun upon formation of a high-power electron beam (500-1000 kW under

steady-state conditions) by the hot cathode and its subsequent transport through the gap under an accelerating voltage of 20-50 kV. The underlying process in the breakdown mechanism is rise of the pressure of residual neutral gases and of the vapor of the treated material. Ionization of the neutral gases by the electron beam results in compensation of its negative charge by ions and in formation of a "beam" plasma which alters the performance of both the electron-optical stage and the beam transporting stage. According to the results of experimental studies with Langmuir probes and x-ray detectors, breakdown occurs 0.7-1 ms after evolution of gases has reached the explosiveness level and this time delay is sufficient for disconnecting the electron gun from its power supply. A fully controllable electron device such as an electron-beam diode or a vacuum tube in the d.c. circuit has been shown, both theoretically and experimentally, to offer better dynamic characteristics than a vacuum circuit-breaker in the d.c. circuit and than an a.c. contactor or parallel-opposing thyristors in the primary circuit of the supply transformer for adequate short-circuit protection of industrial electron-beam equipment. Figures 4; references 12: 11 Russian, 1 German.

UDC 621.391.272

**Cyclic Estimation During Primary Processing of Transducer Signals**

18600005a Moscow AVTOMATIKA I  
TELEMEKHANIKA in Russian No 6, Jun 88  
(manuscript received 23 Feb 87) pp 52-60

[Article by A. A. Krasovskiy, Moscow]

[Abstract] Cyclic estimation of a quantity during primary processing of transducer signals by a Kalman-Bucy filter is analyzed, a quantity being considered which is deterministic during each estimation cycle and an inertialess transducer being used for its measurement. The signal processing time is subdivided into equally long cycles, within each of which the filter operates continuously in time. The quantity which the transducer measures is assumed to be a scalar one appearing with additive white noise but without dynamic distortions. Two ways of approximating it are considered, with a finite Fourier series and with a polynomial. Insertion of threshold device in the error signal circuit is considered as a way to ensure failure-free operation of a filter operating with several transducers of the same quantity or different quantities. As an example is evaluated cyclic estimation of a slowly varying quantity which appears at the transducer input together with a large harmonic interference and an additive white noise. The author thanks S. G. Alyushin for working on the example. Figures 2; references 2: 1 Russian, 1 Western (in Russian translation).

UDC 62-506:62-501.72

**Limit Properties of Adaptive Control System with Identification (Use of Identifiability Equations), Part 1: Object with One Control Input and One Output**

18600005b Moscow AVTOMATIKA I  
TELEMEKHANIKA in Russian No 6, Jun 88  
(manuscript received 24 Mar 87) pp 96-112

[Article by B. G. Vorchik, Moscow]

[Abstract] An adaptive control system with identification is considered for an object with one control input and one output, assuming that only the structure of the object and the structure of the regulator are a priori known. No one particular adaptation algorithm is stipulated, so as to generalize the a priori analysis of such a control system for limit properties and the effect of object identifiability on them, but the estimates of unknown quantities are assumed to converge in time. An object linear with respect to parameters and nonlinear with respect to variables is selected for adaptive control, whereupon the adaptive control system is analyzed for invariance of its regulator and for invariant stability of its limit properties on a parametric set describable by identifiability equations. The description of this set is compared with the description of a parametric set containing the global extremum of limit values of the quadratic norm of residues or limit values of the loss function of a specific adaptation method. The analysis is formalized by seven theorems and a corollary to one of them. The proof to the theorem about object identifiability is given and adaptive control of an object describable by a first-order equation is evaluated numerically on the basis of applicable theoretical relations. Figures 1; references 10: 6 Russian, 4 Western (3 in Russian translation).

UDC 621.315.1:621.372.8:551.510.535

**Self-Focusing and Nonlinear Refraction of Energy-Carrying Microwave Radio Beam in High-Latitude Ionosphere**

18600079a Moscow *RADIOTEKHNIKA I ELEKTRONIKA* in Russian Vol 33 No 9, Sep 88 (manuscript received 12 Jan 87) pp 1793-1796

[Article by P. Ya. Golov and A. N. Kochubey]

[Abstract] Propagation of an energy-carrying microwave radio beam through the high-latitude ionosphere is analyzed, in connection with the project of designing a solar-electric space power plant and in consideration of the known fact that the properties of the high-altitude ionosphere differ from those of the middle-latitude ionosphere. First self-focusing and then nonlinear refraction of such a beam are evaluated on the basis of applicable relations describing phase front distortions and wave perturbation statistics in a stochastic medium such as the ionospheric plasma, heating of electrons by the microwave beam and their subsequent collisions with ions and molecules being evidently responsible for this medium becoming a nonlinear one. The results of this analysis indicate that the conditions in the ionosphere above the polar regions are more favorable for transmission of microwave energy than the conditions in the ionosphere above the temperate regions. References 12: 9 Russian, 3 Western (1 in Russian translation).

UDC 621.372.853.2.049.75

**Dependence of Characteristics of Microstrip Line Loaded by Ferrite Film on Power of Incident Microwave Signal**

18600079b Moscow *RADIOTEKHNIKA I ELEKTRONIKA* in Russian Vol 33 No 9, Sep 88 (manuscript received 25 Mar 87) pp 1839-1845

[Article by V. I. Zubkov and V. N. Kildyshev]

[Abstract] An experimental study of a microstrip line loaded by a Y-Fe-garnet film and transmitting microwave signals as either a surface-magnetostatic-wave device or a backward-volume-magnetostatic-wave device was made, for the purpose of determining its performance characteristics and particularly their dependence on the signal power. The microstrip line with a characteristic impedance of 50 ohms consisted of a 0.500 mm wide conductor strip between a Policor substrate and a Y-Fe-garnet film with an either narrow or wide resonance line grown on a Ga-Gd-garnet substrate. Measurements were made with the signal power varied over the 0.010-0.32 mW/dB range and with a constant longitudinal magnetic field of 550 Oe intensity. The results indicate that, as the signal power is increased, the amplitude-frequency characteristic transforms into one with a smaller difference between transmission and suppression levels and a wider frequency range. In the case of a film with a narrow resonance line, moreover,

the center frequency was found to shift downward or upward depending on operation of the microstrip line as an SMW or BVMW device respectively. The dependence of the transmitted-to-incident power ratio on the incident power was found to be characterized by an intermediate range of a monotonically increasing power ratio between nearly flat low-power and high-power ranges, the quantitative relations here being also determined by the mode of operation and the film characteristics. The authors thank A. V. Vashkovskiy for the few discussions and helpful comments. Figures 4; references 15: 11 Russian, 4 Western.

UDC 621.372.832

**Design of Resistors for Multichannel Cophasal Binary Microwave Power Dividers**

18600079d Moscow *RADIOTEKHNIKA I ELEKTRONIKA* in Russian Vol 33 No 9, Sep 88 (manuscript received 11 Feb 87) pp 1981-1985

[Article by L. P. Gladovich]

[Abstract] Design of decoupling resistors for  $2^m$ -channel cophasal binary  $n$ -stage  $n$ -frequency microwave power dividers in a ring configuration is considered, such a divider being treated as a transmission line. Two fundamental equations are required for calculation of the divider parameters, one giving the input admittance and one giving the output voltage. The design begins with the first stage, its equivalent admittance not depending on yet unknown resistors in the following stages. As a specific example is considered a 4-channel 2-stage divider with a decoupling between channels not less than 32 dB and a voltage standing-wave ratio at the output not larger than 1.122 over an octave wide frequency range. Figures 3; references 4: Russian.

**Comparative Characteristics of Bandwidth-Efficiency-Optimized Gyroresonance Traveling Wave Tubes with  $H_{11}$  and  $H_{01}$  Circular Waveguide Working Modes**

18600178g *RADIOTEKHNIKA I ELEKTRONIKA* in Russian Vol 34, No 3, Mar 89 pp 562-570

[Article by A. V. Kolosov, A. A. Kuraev, and A. I. Shakirin]

[Abstract] This study formulates relativistic averaged nonlinear equations of gyroresonance traveling wave tubes with an irregular waveguide system and an inhomogeneous magnetostatic field for the  $H_{11}$  and  $H_{01}$  working modes. The study reports that the efficiency-optimized gyroresonance traveling wave tube operating at the  $H_{01}$  working mode has a greater length (by a factor of 2), a lower efficiency (6 percent lower) and a narrower amplification band (by a factor of 1.33) compared to a gyroresonance traveling wave tube operating at the  $H_{11}$  mode with identical electron beam parameters and input power. A calculation of the frequency response of this design ignoring the effect of the space charge field



indicates that the average efficiency drops by 2.5-3 percent. The overall comparison results support the contention that the gyroresonance traveling wave tube operating at the  $H_{11}$  mode has significantly better performance characteristics than a similar device operating at the  $H_{01}$  mode. The study also points out that when the dominant  $H_{11}$  mode is used as the working mode in the gyroresonance traveling wave tube the problem of selection of parasitic (interfering) modes at the cyclotron first harmonic is eliminated. This is one of the most important factors in achieving functional stability of gyroresonance traveling wave tubes.

**Constraints on Optimum Parameter Selection for Gyrotrons in Conditions of Mode Competition**  
18600178h *RADIOTEKHNIKA I ELEKTRONIKA* in  
Russian Vol 34, No 3, Mar 89 pp 649-652

[Article by G. S. Nusinovich, A. B. Pavlev, V. I. Khizhnyak]

[Abstract] This study analyzes the issue of how mode competition limits attaining optimum operating conditions over a rather broad range of parameters in gyrotrons. It employs a previously-developed method of analyzing mode competition with a nonequidistant natural frequency spectrum to calculate the efficiency of

single-mode generation and the self-excitation conditions of parasitic modes in the presence of the working mode. A gyatron model is analyzed in a kinetic approximation ignoring the spread of velocities and radii of the electron centers. The analysis revealed that when the gyatron was operated in a pulse mode neither the magnetic field magnitude of the superconducting solenoid nor the beam current could be regulated during the pulse duration. It was determined that virtually the only method of establishing a technique for initial excitation of the working mode and extraction of this mode in single-mode high-efficiency generation is to select the relations between the anode and resonator voltages at the pulse leading edges. The study also provides plots indicating the maximum efficiency in single-mode operation, the parasitic mode self-excitation boundary in CW operation, and analogous boundaries for a beam current that is optimum for one-mode operation and at a current level below the start currents of the parasitic modes. The data provided in the figures indicate that in pulse operation the working length of the resonator should range between  $\mu$  equals 10-13 since at greater  $\mu$  the attainable single-mode efficiency diminishes. The study argues that selecting a more optimum coupling design will make it possible to bring the efficiency of a pulsed gyatron more into line with the value attainable in CW operation.

UDC 621.391.823

**Advisability of Connecting Sheath of Cable To Armor for Shielding Against Magnetic Interference From High-Voltage Transmission Line**

18600073e Moscow ELEKTROSVYAZ in Russian  
No 8, Aug 88 (manuscript received 28 Oct 87) pp 30-34

[Article by L. D. Razumov]

[Abstract] Jumpers between sheath and armor of communication cables are required in all terminal and repeater stations, but the need for them at intermediate points has been recently questioned. In order to resolve the problem, a cable segment is considered in proximity of a high-voltage transmission line which magnetically induces a current in the cable armor. The current which in turn the armor current induces in the cable wire is calculated for a symmetric cable first without and then with jumpers between sheath and armor, assuming that the armor is ideally grounded. The results confirm the advisability of placing jumpers in such a cable segment. When the transmission line is energized at both ends so that the magnetic interference is bilateral, then jumpers are needed in all splicing sleeves within the proximity range. When the transmission line is energized at one end only so that the magnetic interference is unilateral, then jumpers are needed only at both ends of the proximity range and at points where the induced e.m.f. is maximum. Figures 7; tables 2; references 1: Russian.

**Implementation of Adopted Resolutions Without Delay**

18600080a Moscow ELEKTROSVYAZ in Russian  
No 9, Sep 88 pp 1-3

[Article by editorial staff]

[Abstract] Comments made by the USSR Minister of Communications V. A. Shamshin at the 19th All-Union Party Conference are summarized, his comments pertaining to implementation of resolutions adopted at this conference and concerning the best interest of every Soviet person. The status of industry-government relations is reviewed and discussed, in general terms and with reference to the communications sector. As the major causes of delay in implementation of adopted resolutions are identified bureaucratic roadblocking, underutilization of engineering talent, lack of incentives for the individual worker, fuzzy funding of enterprises, and their often irrational financial management. All these causes need to be remedied, if delays in implementation of programs are to be eliminated.

UDC 621.395:621.315.212.654.01

**Accomplishments of C.C.I.T.T.'s 15th Research Commission in 1985-88 Period**

18600080b Moscow ELEKTROSVYAZ in Russian  
No 9, Sep 88 pp 5-8

[Article by L. T. Kim]

[Abstract] The six working groups of the CCITT's 15th Research Commission completed the tasks to which they had been assigned for the 1985-88 period. Group 1 studied transmission of sound broadcasting signals and video telephone signals, the latter including combinations of different standards and video telephone signals for various multifunctional services. Group 2 studied channel switching into the standby mode, monitoring and control system and equipment, and digital channel multiplication system and equipment. Group 3 studied analog-to-digital conversion equipment. Group 4 developed a "Guide to Planning Optical-Fiber Transmission Systems." Group 5 studied characteristics of optical-fiber cables, methods of their measurement, and digital line channels built with such cables. Group 6 studied analog transmission systems, line channels built with metal cables, and characteristics of such cables. The results of these studies as well as new recommendations and corrections of existing ones, based on these studies, will be published in the CCITT's Blue Book.

**Teletypewriter F-2000 With Microprocessor for Electrical Transmission of Documents**

18600080c Moscow ELEKTROSVYAZ in Russian  
No 9, Sep 88 pp 17-22

[Article by H. Fischer and H. Waldmann, German Democratic Republic]

[Abstract] A teletypewriter with a microprocessor has been developed by RadioFunkTechnik (GDR) for unreproachable on-site processing or transmission of texts and other documents. For transmission of cryptograms, this F-2000 teletypewriter can be switched into the GTX mode. It consists of a control microcomputer with a programmable read-only memory and an alphanumeric memory, a numbers storage, a keyboard, a printer, a punch-tape input/output device, and an interface available in several variants for one-terminal or two-terminal operation and for operation with a single-channel audio-frequency telegraph respectively. Service facilities include automatic formation of the top line containing date, time, and identification code, six freely programmable abbreviated standard texts, multi-integral line transfer, format control, tabulation, automatic "end" indication, blocking of unauthorized transmission, FK-G-1001 programmable corrector of channel errors, switching from one mode of operation to another, and self-diagnosis in the programming mode. The printer is controlled by a separate computer. An additional memory-zone with arbitrary sampling is mounted behind the alphanumeric memory or the buffer storage. The power supply, including a pulse-modulation regulator designed for 93-140 or 187-264 V and 40-60 Hz, is equipped with a cooling fan and a radio-interference filter. Figures 2.

UDC 621.3.049.772.1

### Thin-Film Hybrid Micropacks

18600017e Moscow *PRIBORY I SISTEMY*  
*UPRAVLENIYA* in Russian No 6, Jun 88 p 33

[Article by V. A. Bubnov, engineer, and N. K. Yeparkhina, engineer]

[Abstract] Two micropacks MO105UI1 and MO106SA1 have been developed jointly by the Scientific-Industrial Associations "Electron Device" in Yaroslavl and "Borehole Survey" in Leningrad for scientific instruments such as spectrometers and diffractometers. The charge-sensitive direct-coupled amplifier MO15UI1 with a field-effect transistor in the input stage converts charge from an x-ray detector into a voltage signal. The spectrometric amplifier and amplitude discriminator MO106AS1 consists of a high-speed operational amplifier with negative feedback and built-in resistor bank for stepwise gain regulation with high dynamic stability, and a two-level voltage comparator with an anticoincidence circuit in the output stage for amplitude discrimination within a prescribed range with independent regulation of the two levels. Tables 2.

UDC 621.3.087.9:62-524

### Status and Prospects of Thermal Printer Developments

18600017f Moscow *PRIBORY I SISTEMY*  
*UPRAVLENIYA* in Russian No 6, Jun 88 pp 36-38

[Article by K. V. Lvov, engineer]

[Abstract] An overview of current developments in thermal printers is presented, the key component of these shockless printers being the print head. Stationary and moving thermal print heads are available for various applications such as computer data printout and graph plotting, the performance of a stationary print head on moving heat-sensitive paper tape being usually superior to that of a moving print head on stationary heat-sensitive paper sheet. Most thermal printheads now in use are designed for a narrow paper format (40-100 mm wide), some for a wide paper format (up to 220 mm wide). Along with Soviet-made thermal printers (Ts68402, 15VP80, UTP3, Scch6402), not yet produced on a larger scale, there are available foreign-made ones (Star "ST-80R," Texas Instruments "Tigraph 100," Gould "TA 600," Gulton "Versatek 60," IBM "Thermotronic 6750," Fukuda "FCR-11" electrocardiograph). New print heads are not being developed by the Scientific-Industrial Association "Electron Device" in Yaroslavl, largely utilizing thin-film technology and LSI techniques. In addition to the MO110NF1 and MO111F1, there will be developed a print head recording 4 and 3 dots/mm on 57 mm wide and 105 mm wide paper respectively. A built-in printout will make these

printers more competitive with foreign-made ones having it. Another feature will be tape winder with a control keyboard. References 24: 12 Russian, 12 Western.

UDC 621.3.063:621.3.087.9

### Method of Extended Operational Temperature Range of Thermal Printer Matrices

18600017g Moscow *PRIBORY I SISTEMY*  
*UPRAVLENIYA* in Russian No 6, Jun 88 pp 38-40

[Article by V. N. Filatov, candidate of technical sciences, N. A. Preobrazhenskaya, engineer, T. D. Timofeyeva, engineer, and V. N. Voronov, engineer]

[Abstract] A method of making thermal printer matrices operational over a temperature range as wide as from -15°C to 50°C is being developed by the Scientific-Industrial Association "Electron Device" in Yaroslavl, its gist being use of negative feedback through a temperature transducer. It involves heating the thermal printer elements with the heating power varied in accordance with either duration or amplitude of the printing pulse. This is preferable to energy-inefficient thermostatic control with a heater through an automatic regulator requiring not only thermal shields but also forced ventilation and is preferable to preheating the thermal printer elements with an electrical resistance heater from a separate power supply, which does not extend the operational temperature range much anyway. Control on the basis of pulse duration requires use of temperature-insensitive components. Control on the basis of pulse amplitude requires use of temperature-insensitive components. Control on the basis of pulse amplitude requires high amplitudes at low temperatures, which may cause resistor breakdown. Both techniques are being refined by introduction of negative feedback and by use of a thermistor with a maximally linear temperature characteristic, the Soviet-made St1-17 meeting this requirement. The two now commercially produced thermal printer matrices MO110NF1 and MO111NF1 can be modified accordingly, prototypes having been built and having passed relevant tests: operation at temperatures from -15°C to 50°C at 5°C intervals for 30 min at each and operation at 40°C and continuously for 160-300 h or during equivalent (1-2.10<sup>7</sup> temperature cycles. Extending the operational temperatures range below -15°C and above 50°C will require modification of tape winder mechanism to minimize friction and use of more heat-resistant paper respectively. Figures 7; references 16: 12 Russian, 1 East German, 3 Western.

UDC 681.327.11

### Cylindrical Thin-Film Thermal Print Head

18600017 Moscow *PRIBORY I SISTEMY*  
*UPRAVLENIYA* in Russian No 6, Jun 88 pp 40-41

[Article by R. G. Aleksanyan, engineer, and E. I. Sano-syan, candidate of technical sciences]

[Abstract] A new thermal print head has been developed and designed, thin-film resistive heater elements on cylindrical substrate bars, more easy to fabricate and to

miniaturize than a planar head with a mesa structure. Additional advantages are no wear of the protective coating and low driving power requirement. The substrate bars are made of S48-5 nonalkalic glass characterized by high chemical stability and high heat resistance, its softening temperature being 725°C. The protective coating is a triple-layer film of 0.0005 mm thick  $\text{SiO}_2$ ,

0.0035-0.005 mm thick polysilicon, and 0.0005-0.001 mm thick  $\text{Si}_3\text{N}_4$ . The performance characteristics of this TPG 072001 thermal print head are: resolution 2.9 dots/mm, printing pulse duration 1.75 ms, printing pulse power 1.25 W, energy requirement 2.3 mJ/dot, minimum pulse repetition time 3.5 ms. Figures 3; tables 1; references 1: Russian.



UDC 681.2:658.53

**Status and Development of State-Authorized Product Testing and Certification at USSR Ministry of Control and Automation Instrument Manufacturing Industry**

18600017a Moscow PRIBORY I SISTEMY  
UPRAVLENIYA in Russian No 6, Jun 88 pp 1-3

[Article by I. M. Gryaznov, candidate of technical sciences, director, Department of Testing and Certification, All-Union Scientific Research Institute of Metrology, Testing, and Instrument Design Standardization, L. M. Zaks, candidate of technical sciences, and N. G. Sherstyukov, candidate of technical sciences]

[Abstract] The status of state-authorized instrument testing and certification is reported with the aid of an organization chart showing administration and technical lines of responsibility as well as division of responsibility at the central ministerial and territorial levels, this chart also listing academic institutions and industrial enterprises involved is design research and production of instruments respectively. Testing and certification procedures are outlined, whereupon advance planning and engineering in two stages is overviewed. The need for meeting specifications and the means of achieving this rank high on the agenda, along with the problems of a low average tool availability factor (57 percent) and a low average test equipment utilization factor (35 percent) in the 213 enterprises under jurisdiction of the USSR Ministry of Control and Automation Instrument Manufacturing Industry. Figures 1; references 2.

UDC 658.512.2.011.56:658.274:002

**Automation of Layout Design of Special-Purpose Assemblies with Aid of 'MikroDAT' Facilities**

18600017b Moscow PRIBORY I SISTEMY  
UPRAVLENIYA in Russian No 6, Jun 88 pp 4-5

[Article by T. B. Ponomarenko, candidate of technical sciences, and V. N. Borovik, candidate of technical sciences]

[Abstract] A computer-aided design system for layout of microprocessor assemblies to be used for automatic control of technological processes at local levels has been developed at the Kiev Institute of Automation, with MicroDAT hardware designed and produced by the Scientific-Industrial Association "Automatic Control Systems" in Kharkov. It facilitates layout design through all stages and includes additional special data processing procedures. Primary document of the functional-logic structure is encoded in a secondary document for input to the computer, which then lays out the power distribution and the functional components from data input to data output with graphic or alphanumeric display, routes internal connections, wires the board for external connections between components and to the power supply, and reads out the technical document for factory order. The system provides for intermediate design analysis and design revisions. Figures 3; references 4: 3 Russian, 1 Western.

UDC 681.327.11:621.397

**Interactive Display of Graphic Data on Color Television Screen with Aid of Camac Apparatus**

18600017c Moscow PRIBORY I SISTEMY  
UPRAVLENIYA in Russian No 6, Jun 88 pp 12-13

[Article by A. A. Lapin, candidate of technical sciences, I. V. Milovanov, candidate of technical sciences, S. A. Vasilyev, engineer, O. V. Reshetova, engineer, and Ye. V. Marshankina, engineer]

[Abstract] A data processing subsystem for display of graphic or alphanumeric information on a color television screen is proposed which uses the CAMAC apparatus for this purpose. Its modes of operation include reference lookup and change of color palette. The software contains programs to encode a new letter pattern for storage in the data base, to retrieve it from the data base for display with a different color palette or to a different scale, to remove it from the data base, and to display it on a color monitor screen by interaction with a typewriter. All programs are written in PASCAL and in MACRO-11 language for a Distributed File Processing operating system. The subsystem is compatible with an SM-4 minicomputer such as Elektronika-100/25. Figures 2.

UDC 621.314.6

**Converters with Semiconductor Devices in Power Supplies for Magnetodynamic Equipment**

18600004a Kiev TEKHNIЧЕСКАЯ

ELEKTRODINAMIKA in Russian No 4, Jul-Aug 88

(manuscript received 26 Feb 88) pp 37-46

[Article by Boris Pavlovich Borisov, candidate of technical sciences, department head, Institute of Electrodynamics, UkSSR Academy of Sciences, Kiev]

[Abstract] The design of power supplies for industrial magnetodynamic equipment and specifically magnetodynamic casting machines is reviewed, such a machine consisting of usually two inductors and an electromagnet. Design analysis of the power supply and performance analysis of the magnetodynamic machine, the performance of the latter depending on the design of the former, are based on the equivalent circuit diagram with the machine as load and the power supply as source. Use of semiconductor devices, specifically thyristor voltage regulators, in the power supply is considered in conjunction with conventional inductive converters (transformer or autotransformer) and capacitive converters for both the electromagnet and the pair of inductors. In addition are also analyzed a typical scheme with a resonance inverter including an implicit d.c. component, various schemes based on thyristor voltage regulators with phase control for either common or separate and thus independent power supply to the electromagnet and to the inductors, and also schemes based on autonomous voltage inverters with frequency regulation as an additional means of regulating the electromagnetic pressure in the machine. Figures 5; tables 1; references 7: Russian.

UDC 621.316.722

**Damping of Periodic Pulse Interference at Input to Discrete Voltage Regulators**

18600004b Kiev TEKHNIЧЕСКАЯ

ELEKTRODINAMIKA in Russian Jul-Aug 88

(manuscript received 17 Jun 87) pp 47-53

[Article by Valentin Yegorovich Boltnev, candidate of technical sciences, senior scientific associate, Ryazan Institute of Radio Engineering]

[Abstract] Connecting a discrete a.c. voltage regulator-stabilizer to the a.c. network through a damping LC-filter outside the main feedback loop is proposed for suppressing periodic pulse interference without degrading the stability of automatic control when the transfer ratio of the regulator is changed discretely at discrete instants of time by a pulsed relay, such a regulator-stabilizer with output voltage quantization and with time discretization consisting of a transformer-and-switch control element between an input modulator and an output demodulator-rectifier. The advantage of inserting an LC-filter over enlarging the output filter is demonstrated by theoretical analysis of the voltage regulation-stabilization process

under given conditions. Such a filter is subsequently designed with standard component, K73 capacitors and DVCh2 chokes, whereupon its performance is evaluated with simplifying approximations which do not result in an error larger than 15 percent over wide ranges of values of the design variables. Figures 5; references 6: Russian.

UDC 621.314.5

**Tracking Control of Autonomous Voltage Inverters**

18600004c Kiev TEKHNIЧЕСКАЯ

ELEKTRODINAMIKA in Russian No 4, Jul-Aug 88

(manuscript received 5 Jun 87) pp 58-64

[Article by Valeriy Yakovlevich Zhuykov, doctor of technical sciences, professor, Kiev Polytechnic Institute, and Ryszard Strzelecki, candidate of technical sciences, Engineering Academy, Bydgoszcz (Poland)]

[Abstract] Tracking control of an autonomous voltage inverter is considered, its advantage being the possibility of high-speed response and wide-range regulation but its drawback being the appearance of subharmonics and a dependence of the rectifier switching frequency on the waveform of the tracked signal. The problem of control optimization, involving a tradeoff between switching frequency and tracking accuracy, is solved on the basis of anticipation with extrapolation of the feedback signal and with either a forecasting model or an anticipating component in the control system. The conditions for successive sampling of voltage levels are established, following an analysis of all possible ways in which the next voltage level can be selected. The switching frequency is estimated for the case of a resistive-inductive load-feedback circuit. Optimal tracking in accordance with the algorithm of successive voltage level sampling, adequate in the case of a narrow insensitivity zone and readily achievable with simpler automation logic, implies that a lower switching frequency is required and that its range of variation becomes narrower, which simplifies filtration, as the number of permissible voltage levels increases. Figures 3; references 14: 8 Russian, 1 Polish, 5 Western.

**Mathematical Model of Electromagnetic Fields From Complex Sources**

18600165a TEKHNIЧЕСКАЯ

ELEKTRODINAMIKA in Russian No 1, Jan 89 pp 3-6

[Article by V. Ya. Lavrov]

[Abstract] This study develops a mathematical model of the electromagnetic fields produced by complex sources based on a solution to a vector wave equation. The solution of the vector wave equation can be reduced in a spherical coordinate system by means of the electric oscillation potential to a solution of the scalar wave equation. This mathematical model makes it possible to calculate electromagnetic fields for the case of various positions of the initial field sources with respect to an annular region accounting for the response of the

medium within this region. However, when the annular region is located between the primary field sources a comprehensive solution can be obtained by combining two particular solutions, one of which is obtained when the primary field sources are located outside the annular region while the other solution is obtained for the field sources located within the region.

**Approximate Mathematical Model of the Electrical Field of Disk-Type and Conical Insulators Under Constant Voltage**

18600165b Kiev TEKHNIЧЕСКАЯ  
ELEKTRODINAMIKA in Russian  
No 1, Jan 89, pp 6-10

[Article by M. Ye. Ierusalimov, O. S. Ilenko, Ye. K. Volpov, Ye. G. Kuzmina]

[Abstract] This study develops an approximate mathematical model for analyzing the features of electrical fields produced by disk-type and conical insulators under long-term application of a d.c. voltage. The derived calculation relations make it possible to analyze the tolerable voltage level from the inner radius of the insulator for a given maximum field strength and a specific  $\beta$  factor. In the particular case under analysis the greatest tolerable voltage is achieved at an inner-to-outer radius ratio of near 1.4. This approximate mathematical model can be used in an approximate calculation of electrical fields in disk-type and conical insulators under constant voltage accounting for the dependence of the dielectric conductivity on field strength. The dependence of conductivity on field strength serves to equalize the field and substantially reduces (by approximately 25 percent) the maximum field strength and also influences the optimum inner-to-outer radius ratio of the insulators.

**Mathematical Modeling of Asynchronous Motors for Operational Optimization of Auxiliary Electric Drives at Fuel-Fired and Atomic Power Plants**

18600165e Kiev TEKHNIЧЕСКАЯ  
ELEKTRODINAMIKA in Russian  
No 1, Jan 89 pp 69-74

[Article by G. L. Baranov and V. N. Zhukov]

[Abstract] This study This article uses structural modeling techniques for direct computer modeling of controlled electric drive operation in auxiliary power generating units, fuel-fired, and atomic power plants. The model developed in the present article is valid for both steady-state and transient operating conditions. Modeling of the processes occurring in the electrical circuits and the motor regulator circuitry makes it possible to make certain traditional assumptions in the analysis, including that the stator and rotor windings are three-phase windings and are symmetrical in both the magnetic and electrical senses, no steel saturation is present, and the spatial magnetization forces are sinusoidal in the air gap and no nonuniformity of the air gap is present. A

computer-aided design system employing structural modeling is used to numerically solve the equations in this mathematical model. The run time on an YeS-1061 computer is 58 sec in calculation steps of .001 sec and a duration of 0.5 sec for the transient process where a d.c. generator is activated when the stator winding is under full voltage and the rotor windings are short-circuited with the moment of resistance equal to zero. Measurements of the rotation speed of the a.c. generator rotor and the rotational electric torque are in good agreement with experimental data. This model can be used to investigate both the transient and steady-state operating conditions in auxiliary power generating units, fuel-fired power plants and atomic power plants.

**Pulsed-Periodic Magnetic Field Generators**

18600165c Kiev TEKHNIЧЕСКАЯ  
ELEKTRODINAMIKA in Russian  
No 1, Jan 89 pp 11-16

[Article by B. Z. Movshevich and Ye. A. Kopelovich]

[Abstract] This study considers generators producing magnetic field pulses of a few Tesla characteristic of many applications. The analysis focuses on the influence of the voltage level and waveform on storage capacitors used in generators and related losses as well as their service life and reliability. These parameters are important in that they are largely responsible for the maximum pulse repetition rate and reliability of pulsed magnetic field generators. It is demonstrated that by converting to a unipolar voltage operation the spread of voltages in the storage capacitors drops and the calculation formulae suggest that their reliability and the overall reliability of the generator will improve significantly. A prototype pulsed magnetic field generator is also developed on the basis of the analysis; this design makes it possible to produce quasi-square-wave current pulses of up to 2 kA in amplitude in a 600 micro Henry solenoid by means of a passive shaping network. The magnetic field induction in the solenoid was 4 Teslas at a pulse repetition rate of 20 Hz.

**Analysis of Inverter Operating Conditions in a Superconducting Converter**

18600165d Kiev TEKHNIЧЕСКАЯ  
ELEKTRODINAMIKA in Russian  
No 1, Jan 89 pp 35-40

[Article by A. V. Novoseltsev, Yu. V. Skobarikhin, S. V. Nepogodev]

[Abstract] This study considers a variety of inverter operating conditions of superconducting converters that employ resistance and voltage switching. The analysis is carried out for a superconducting converter in a single-phase full-cycle circuit design with a null conductor, although the relations obtained from this analysis are

also applicable to bridge-type superconducting converters. The primary elements of the superconducting converter are the cryotrons and a superconducting transformer whose primary low-current winding is connected to the power supply or to the load, while the secondary high-current winding is connected to the cryotrons and the inductive load. It is determined from an analysis of various types of inverter operating conditions that the

duration of the switching interval represents the control characteristic of conditions employing voltage switching and, since the duration of the switching interval is proportional to the current in the superconducting magnet circuit, the control characteristics of these operating conditions is a linear one which significantly simplifies the process of designing an automatic control system for the superconducting converters.



UDC 621.316.542.027.3.621.3.06.001.4

**Switching Tests Performed on 1150 kV Circuit Breaker Under Service Conditions**

18600002a Moscow ELEKTROTEKHNIKA in Russian No 7, Jul 88 (manuscript received 2 Oct 87) pp 24-28

[Article by V. Z. Annenkov, candidate of technical sciences, A. N. Komarov, candidate of technical sciences, S. V. Biryukov, engineer, Ye. B. Volkov, engineer and L. P. Sorokina, All-Union Institute of Electrical Engineering imeni V. I. Lenin]

[Abstract] A pole of a VNV-1150-3200-40U1 air circuit-breaker was tested for switching performance under service conditions in the high-power 1150 kV - 50 Hz cage in Togliatti, this circuit breaker being manufactured by the Industrial Association "Ural Heavy Electrical Machinery." Its pole consists of two half-poles, one containing two double-break arc quenchers and one containing three double-break arc quenchers with switchable shunting resistors each. After mechanical tests and adjustments, high-voltage single-phase switching tests were performed in four operating modes but without 1150 kV overhead transmission lines in the circuit: 1) with two 500/1150 kV autotransformers connected in phase opposition, 2) with an RVMK-1150 shunting reactor, 3) with an 1150/500/20 kV power autotransformer in the connect-disconnect mode under no load, 4) switching the capacitive current where two NDYe-1150 voltage transformers with a total capacitance of approximately 5000 pF operate in parallel with their primaries connected to the 20 kV opposing winding segment of a supply autotransformer. The tests involved several hundred switching cycles over a period of several thousand hours. Figures 7.

UDC 621.315.21:538.945:621.3.013

**Distribution of Magnetic Field in Superconducting Topological Generator**

18600002c Moscow ELEKTROTEKHNIKA in Russian No 7, Jul 88 (manuscript received 13 Oct 86) pp 47-50

[Article by Yu. F. Antonov, A. V. Osipyan, and V. N. Shakhtarin]

[Abstract] The distribution of the magnetic field in a superconducting topological generator is calculated for the purpose of design analysis, the TPG-9 machine similar to but smaller than the TPG-4/1 machine being selected as model. This machine features an inductor-yoke split along the slotted ferromagnetic stator core and a 0.025 mm thick sheet (60 mm wide, 80 mm long) of Nb with 1.5 pct Zr as armature winding wrapped around a 1 mm thick glass-textolite cylinder and covered with electrical insulation cardboard inside the ferromagnetic rotor core. Theoretical data are based on iterative numerical solution of the Laplace equation for the axial component of the magnetic vector potential, first without a superconducting sheet of with a sheet in the normal

state and then with a superconducting sheet but with existence of a normal zone taken into account. Calculations were made with the width of the normal zone rigidly fixed, with its width first fixed and then corrected after several iterations, and with its width unknown to be determined in the process of calculations. Experimental data are based on measurements with six Hall probes in key locations. The armature winding was cooled with He vapor, its transition from superconducting to normal state being monitored by one of the Hall probes. The results of this study include distribution of the radial component of magnetic induction (zero normal and tangential components) and of the magnetic field intensity around the air gap, also the penetration depth of the magnetic field in the superconducting armature winding-sheet opposite stator teeth and slots. Figures 5; references 5: 1 Russian, 4 Western.

UDC 621.316.719.2:621.313.13

**Fast-Response Electromagnetic Brakes for High-Torque Electric Motors**

18600002d Moscow ELEKTROTEKHNIKA in Russian No 7, Jul 88 p 75

[Article by A. A. Sokolov, engineer, N. I. Rychkova, engineer, F. Ya. Masalimov, engineer, I. V. Bochkarev, candidate of technical sciences, and N. A. Baukov, candidate of technical sciences]

[Abstract] Two fast-response electromagnetic brakes NZTV 11-11 and NZTV 11-09 respectively for VEM2 (17/34 N.m) and VEM1 (7/14 N.m) high-torque electric motors in machine-tool and robot drives have been developed and assigned to production by the Experimental-Scientific Research Institute of Metal-Cutting Machine Tools. Brake action is provided by springs pressing the brake shoes to the motor shaft and release action is provided by the pulling force of electromagnet, with the membrane on which the brake shoes are mounted respectively bending to ensure tight contact and straightening to provide clearance. The brakes deliver torques not lower than 12.5/25 N.m and 5/10 N.m respectively. Brake action and release action occur within not more than 0.055 s and 0.07 s respectively (NZTV 11-11), within not more than 0.035 s and 0.05 s respectively (NZTV 11-09). Figures 1; tables 1.

UDC 621.311.4.016.2.005.001.24

**Method of Setting Power Limits**

18600016a Moscow PROMYSHLENNAYA ENERGETIKA in Russian No 6, Jun 88 pp 2-3

[Article by V. I. Gordeyev, candidate of technical sciences, and A. V. Demura, candidate of technical sciences, Novocherkassk Polytechnic Institute]

[Abstract] A method of setting power limits for enterprises in planning the operation of a power distribution system is proposed which takes into account wide fluctuations of the power demand. First the power drawn by



each enterprise is averaged over each of the two work shifts which coincide with morning and evening peak-load hours respectively. A correction factor is then introduced for operation under the daily limit and the power distribution among enterprises is recalculated accordingly. Finally, the deviation of nominal power from average-per-shift power is determined and the relative limit on these deviations in all enterprises is added to the average-per-shift power. The calculation procedure is demonstrated on the problem of distributing 2400 kW among five enterprises during morning peak-load hours when the total nominal power demand by all five enterprises adds up to 3000 kW. This method limits most the power of enterprises with the largest deviation of maximum power from average power. Figures 2; tables 1.

UDC 621.311.016.25.077

#### **Adjustable Setting of Longitudinal Capacitive Compensation**

18600016b Moscow *PROMYSHLENNAYA ENERGETIKA* in Russian No 6, Jun 88 pp 26-29

[Article by A. I. Ignaykin, candidate of technical sciences, and V. G. Bugakov, engineer, Vologda Polytechnic Institute]

[Abstract] Adjustable setting of longitudinal capacitive compensation in power distribution networks operating under variable heavy load is considered, the authors having invented and designed an apparatus for automatic adjustable compensation setting directly at the users' terminals so that the nominal voltage at the users' end can be maintained during voltage, current, and phase angle fluctuations. The apparatus responds to these changes according to the principle of optimal automatic control. In addition to a series or parallel switchable capacitor bank with a set of thyristor switches (six T-630-22 per phase), the apparatus includes a current transformer and a potential transformer, a pair of voltage deviation and current deviation discriminators, a phase detector, a pair of voltage deviation and current deviation discriminators, a phase detector, a pair of voltage signal and current signal amplifiers-limiters, and a summing circuit which controls the compensation setting. The apparatus was tested with an oscillograph for analysis of its regulation characteristics and with a mine fan driven by a 1500 kW synchronous electric motor for performance evaluation, three parallel groups of four KSP-0.66-40 capacitors in series per phase compensating the inductive reactor reactance and the inductive cable reactance as well as part of direct-axis subtransient motor reactance. Figures 4; Russian.

UDC (621.181:662.613.5):546.174.001.2

#### **Prospects of Lowering NO<sub>x</sub> Emission by Industrial Boilers**

18600016c Moscow *PROMYSHLENNAYA ENERGETIKA* in Russian No 6, Jun 88 pp 38-41

[Article by V. I. Gushcha, engineer, USSR Ministry of Power and Electrification, and V. R. Kotler, candidate of technical sciences, All-Union Institute of Heat Engineering imeni F. E. Dzerzhinskiy]

[Abstract] Emission of NO<sub>x</sub> gases by industrial boilers is analyzed from the standpoint of lowering its temporarily permitted to maximum permissible levels, considering the various mechanisms of their formation. Mainly thermal and some fast NO<sub>x</sub> gases are produced by oxidation of atmospheric nitrogen behind the flame front (high temperature) and at the flame front (low temperature) respectively during combustion of hydrocarbons, thermal NO<sub>x</sub> gas being produced at a rate exponentially dependent on the temperature and less strongly dependent on the oxygen concentration. Nitrogen contained in some fuels oxidizes during combustion of the latter. The basic three countermeasures are lowering the maximum temperature (recirculation of flue gases, injection of moisture, cooling the hot air, sectionalizing the furnace chamber by insertion of screens, distributing the flame over the furnace height), lowering the oxidizer concentration (nonstoichiometric combustion, stagewise combustion, burners with drawn out mixing), and special combustion techniques (combustion in fluidized bed, combustion after heat pretreatment of the fuel, reduction of NO<sub>x</sub> in the furnace). Burners with adjustable injection of primary air and precombustion with oxidizer deficiency in a forechamber are special combustion techniques which also involve lowering of the oxidizer concentration. All these methods are evaluated comparatively in terms of technical and economic indicators. They are being developed and implemented, some in the USSR and some in Western countries. A latest development is three-stage combustion with reduction of NO<sub>x</sub> gases already within the furnace. Figures 4; references 4; 2 Russian, 2 Western.

UDC 621.313.13.017.72

#### **New Technical Means of Air Conditioning Explosion-Proof Electric Motors**

18600018a Moscow *ELEKTROTEKHNIKA* in Russian No 6, Jun 88 (manuscript received 8 Apr 87) pp 12-15

[Article by N. M. Makula, candidate of technical sciences, V. G. Drenko, engineer, P. I. Zakharchenko, engineer, and I. Ye. Lizenko, engineer]

[Abstract] Considering the high rate of failures of large industrial explosion-proof electric motors because of moisture condensation inside the enclosure and consequent breakdown of the winding insulation, it has been

found necessary to devise means of air conditioning the inside of the motor enclosure. An engineering study of this problem was made, an EKV4U motor with organo-silicon winding insulation being comprehensively tested in a KTK-3000 temperature-humidity chamber. An analysis of the data on evaporation and condensation of moisture at the insulation surface during heating (operating) and cooling (standstill) periods respectively has revealed that the absolute humidity inside the motor enclosure is linearly dependent on the temperature as well as an exponential function of time. On this basis has been developed a heat exchanger consisting of two tubes between two plates and utilizing action of the internal motor fan as well as that of rotor bar extensions. Its installation requires only drilling two holes in the motor housing and welding the tubes to the housing after they have been mounted in the holes. This heat exchanger was designed for and tested in EDK04 totally-enclosed fan-cooled-motors. One motor was tested first in three ways: with dry insulation, with successively 30, 60, 90 grams of water poured in, and then with the new heat exchanger installed. Three such motors were tested next, under operating and standstill conditions without and with the heat exchanger. Such a heat exchanger was also designed for EKV4U motors. Figures 5; references 3: 2 Russian, 1 Czechoslovak.

UDC 62-83:621.313.2.001.5

#### **Electromechanical Manipulator**

18600018b Moscow ELEKTROTEKHNIKA in Russian  
No 6, Jun 88 (manuscript received 16 No 87) pp 54-57

[Article by A. M. Litvinenko, candidate of technical sciences]

[Abstract] The performance of an electromechanical manipulator for industrial robots is analyzed, such a manipulator having been designed with external electromagnets in the drives for each degree of freedom. Two vertical pairs and two horizontal pairs of cores are mounted on the inside wall of cylindrical housing through cleats, each core with a plunger extending inward and gripping a hinge joint of the manipulator arm also mounted inside the cylinder to its walls anagously through four pairs of springs. The performance analysis is based on the three-dimensional kinematic scheme and the two-dimensional mass-spring model of such a manipulator, also on the equivalent diagram of a

spring. Each spring is represented by only one translational and five rotational kinematic pairs involving five links besides the arm so that all eight springs together form together with the arm 48 kinematic pairs. On the basis of Lagrange's equations of motion are established the kinetic-potential energy relations in such a manipulator and its vibration characteristics in all modes corresponding to its degrees of freedom. The manipulator is positioned sequentially from one support to another in cycles. It can be controlled by antiphasal, cophasal, and combined actuation of the electromagnets, with the velocity of plungers reaching 1.5-2 m/s and thus adequate for nominal manipulator productivity in handling light micro-electronic and radioelectronic parts. Figures 5; references 5: Russian.

UDC 621.313.13-133.32-181.48

#### **Harmonic Single-Phase Electric Stepper Motors with Multipole Permanent Magnets**

18600018c Moscow ELEKTROTEKHNIKA in Russian  
No 6, Jun 88 (manuscript received 1 Jul 87) pp 77-79

[Article by A. M. Znov, engineer, A. N. Sokolov, engineer, and I. M. Paliy, candidate of technical sciences]

[Abstract] Harmonic single-phase stepper motors are considered, in those of the inductor type the starting torque being produced by synthesis of harmonic components of the static synchronizing torque. Such harmonic stepper motors have excellent dynamic characteristics, but require high manufacturing precision of the teeth. A multipole permanent-magnet version with claw-teeth not requiring such precision is proposed, application of the same principle of harmonic synthesis yielding equally excellent performance characteristics without an increase of motor size. The design is demonstrated on a motor with a static synchronizing torque which consists of only first and second harmonics. The second harmonic is here produced by a second group of teeth and not by the same group, as in a motor of the inductor type, as a result of modulation of the magnetic flux during rotation. The fundamental first harmonic is produced by interaction of magnetic flux and armature current, as usual. The already commercially produced DSh21-0.00005-22.5 motor operates on 6 V in 22.5° steps with a starting torque of  $2 \cdot 10^{-4}$  N.m and a running torque of  $1 \cdot 10^{-4}$  N.m under a "dry friction" load, the nominal moment inertia of the load being  $0.05 \text{ g.cm}^2$ . Its overall size is 21 mm diameter and 13 mm length. Figures 3.

UDC 621.3.018

**Design of Electromagnetic Brake with Nonmagnetic Rotor**

18600007a Novocherkassk IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY:

ELEKTROMEKHANIKA in Russian No 6, Jun 88  
(manuscript received 7 Dec 87) pp 35-44

[Article by Leonid Alekseyevich Potapov, candidate of technical sciences, docent, Bryansk Institute of Transportation Equipment Construction]

[Abstract] The design of an electromagnetic brake with a nonmagnetic hollow cylindrical rotor and its performance are analyzed in accordance with electromagnetic field theory, with the transverse edge effect and the saliency of inductor poles accounted for by appropriate coefficients in calculation of the electromagnetic torque. The system of applicable Maxwell equations, supplemented with the continuity equation for the current, is solved for symmetric or asymmetric rotor overhangs, a unipolar inductor, and a square distribution of magnetic induction around the air gap, the magnetic induction having an axial component only. The design procedure consists of seven steps: 1. locate the maximum point of the mechanical characteristic, 2. calculate the insider rotor radius, 3. calculate the magnetic Reynolds number for the lowest rotor speed, 4. select length-to-radius ratios on the basis of structural considerations and then, on this basis, calculate the inductor length and the rotor length as well as the edge-effect correction factor, 5. calculate the magnetic induction and reconcile the obtained magnitude with specification by repeating steps 2-3-4 with revised values of the design parameters, 6. calculate the rotor cooling surface and the maximum thermal flux crossing it, 7. design the magnetic structure and the excitation winding according to standard procedure. Figures 5; references 4: Russian.

UDC 621.3.013

**Computer-Aided Analysis of Inductive Transducers for Magnetic Measurements**

18600007c Novocherkassk IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY:

ELEKTROMEKHANIKA in Russian No 6, Jun 88  
(manuscript received 30 Jan 87) pp 110-114

[Article by Yuriy Aleksandrovich Molchanov, engineer, Vladimir Polytechnic Institute]

[Abstract] A computer program in FORTRAN-4 has been written for design and performance analysis of inductive transducers, specifically two transducers for inspection and testing of magnetic materials and structures by the method of field intensity measurement and magnetic flux compensation. Each transducer consists of the permeameter core carrying the magnetizing coil and the potentiometer core, with the compensating coil wound on the potentiometer core in the type-1 transducer (both cores on the same side of test piece) or around the test piece in the type-2 transducer (the two cores on opposite sides of test piece). Calculations by the method of finite elements are based on the Poisson equation for the vector potential of a plane-parallel static magnetic field. The program was tested for accuracy on problems with known analytical solutions and the discrepancy was found not to exceed 0.5 percent. The program was used for determining the dependence of the measurement error on two potentiometer design parameters: width of interpolar space and pole width. It was found to decrease monotonically with increasing pole width at a fixed width of the interpolar space and, with a fixed pole width, to be minimum at some width of the interpolar space which becomes smaller as the pole width is increased. Figures 8; references 5: 4 Russian, 1 Western (in Russian translation).

UDC 621.315.592

### Hot Electron Transistors (Review)

18600068a Leningrad FIZIKA I TEKHNIKA  
POLUPROVODNIKOV in Russian Vol 22 No 9, Sep 88  
(manuscript received 20 Aug 87, signed to press  
14 Mar 88) pp 1537-1556

[Article by V. L. Borblik and Z. S. Gribnikov, Institute of Semiconductors, UkSSR Academy of Sciences, Kiev]

[Abstract] Developments in the theory and the technology of hot-electron transistors over the 1981-87 period are reviewed, beginning from Shannon's silicon devices and implantation technique of producing a potential barrier between the strongly doped  $n^{2+}$ -region and the weakly doped substrate. The next developments are HET on a GaAs structure with planarly doped barriers grown by molecular-beam epitaxy, on a GaAs/ $Al_xGa_{1-x}As$  or other heterojunction structure, tunnel-resonance HET, and monolithic HET with metallic or superconducting base. Experimental research has been supplemented with theoretical research concerning particularly the physical properties of hot-electron transistors, electronic processes in them on which their mechanism and performance depend, the effect of a magnetic field, and hot-electron spectroscopy as an outstanding application for these low-gain transistors. Figures 18; references 98: 6 Russian, 92 Western.

### Laser Annealing of GaAs Doped by Ion Implantation. Role of Implantation Defects

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POLUPROVODNIKOV in Russian Vol 22 No 9, Sep 88  
(manuscript received 23 Jul 87, signed to press  
26 Jan 88) pp 1563-1568

[Article by V. N. Yakimkin, V. V. Ushakov, A. A. Gippius, V. S. Vavilov, A. E. Sedelnikov, V. A. Dravin, V. V. Chernyayev, and N. Yu. Ponomarev, Institute of Physics imeni P. N. Lebedev, USSR Academy of Sciences, Moscow]

[Abstract] An experimental study of GaAs crystals doped by ion implantation at room temperature and then annealed by laser treatment was made, n-GaAs single crystals and epitaxial layers with  $5 \times 10^{15}$ - $3 \times 10^{18} \text{ cm}^{-3}$  concentrations of free electrons being doped with Zn, Nb, Ta, W ions of up to 350 keV energy in doses of  $8 \times 10^{12}$ - $5 \times 10^{14} \text{ cm}^{-2}$ . They were subsequently treated with 694.3 nm radiation from a Q-switched ruby laser in pulses of 40 ns duration, the energy density on the crystal surface being varied over the 0-3 J/cm<sup>2</sup> range. For comparison and control, also intrinsic GaAs crystals were treated with such laser pulses and doped GaAs crystals were only heat treated at temperatures of 100-800°C under a protective SiO<sub>2</sub> film. Analysis of the edge band in the luminescence spectra and of the results of Rutherford backscattering spectrometry indicate inadequacy of treatment with nanosecond laser pulses after ion implantation, evidently owing to the high mobility of

radiative point defects which at room temperature spread beyond the amorphized regions and thus inhibit annealing. Figures 3; references 14: 2 Russian, 12 Western.

### Heterovariband GaAlAs Photocell: Spectral Analog of Eye. Part I: Model

18600068c Leningrad FIZIKA I TEKHNIKA  
POLUPROVODNIKOV in Russian Vol 22 No 9, Sep 88  
(manuscript received 29 Oct 87, signed to press  
1 Apr 88) pp 1634-1639

[Article by B. I. Reznikov, A. A. Stamkulov, T. I. Taurbayev, V. V. Tsarenkov, and G. V. Tsarenkov, Institute of Engineering Physics imeni A. F. Ioffe, USSR Academy of Sciences, Leningrad]

[Abstract] A heterovariband GaAlAs photocell is considered for simulation of the eye, its quantum efficiency spectrum most closely approximating the eye sensitivity spectrum. As the first step, a model structure of such a cell is constructed for theoretical analysis. It consists of a homo-wideband p-region which is illuminated and a narrow-variband n-region where the gradient of the threshold energy for direct optical transitions has a fixed orientation relative to the heterojunction. The quantum efficiency of the photoelectric effect, equal to the short-circuit current density divided by the product of photon flux density in the structure and electron charge, is evaluated as the sum of three integrals representing the contributions of the space-charge region and of the two quasi-neutral p,n regions respectively. In order to evaluate the contributions of these two regions, it is necessary to calculate their optical thicknesses from the absorption spectrum of the GaAlAs solid solution. That spectrum is almost exponential in the low-energy range and almost linear in the high-energy range, the threshold energy for direct optical transitions being the dividing point between these two ranges. The essential four parameters on which the quantum efficiency spectrum depends are found to be: threshold energy levels  $E_{G/O}^G$  and  $E_{G/b}^G$  for direct optical transitions in the variband n-region and in the illuminated wideband p-region respectively, optical thickness  $t_{Ob}$  of the p-region at the threshold energy level  $E_{G/b}^G$ , and band variation index  $g$  (0 in p-region and approximately equal to absolute value of  $\Delta E^G$  in n-region). Calculations show that the maximum of the quantum efficiency spectrum shifts toward shorter waves (lower energy) as  $E_{G/O}^G$ ,  $E_{G/b}^G$ ,  $g$  increase and  $t_{Ob}$  decreases, that the half-width of the spectrum decreases as  $E_{G/O}^G$ ,  $g$ ,  $t_{Ob}$  increase and  $E_{G/b}^G$  decreases, also that the slope of the long-wave edge of the spectrum at the 1/2max point on this side is determined essentially by  $g$  only and decreases as  $g$  increases while the slope of the short-wave edge of the spectrum at the 1/2max point on this side is determined essentially by  $t_{Ob}$  only and increases as  $t_{Ob}$  increases. All other 8 parameters of the heterovariband p-n structure are found to be nonessential. Figures 3; references 5: 4 Russian, 1 Western (in Russian translation).



**Heterovariband GaAlAs Photocell: Spectral Analog of Eye. Part II: Experiment**

18600068d Leningrad FIZIKA I TEKHNIKA  
POLUPROVODNIKOV in Russian Vol 22 No 9, Sep 88  
(manuscript received 29 Oct 87, signed to press  
1 Apr 88) pp 1640-1646

[Article by B. I. Reznikov, A. A. Stamkulov, T. I. Taubayev, B. V. Tsarenkov, and G. V. Tsarenkov, Institute of Engineering Physics imeni A. F. Ioffe, USSR Academy of Sciences, Leningrad]

[Abstract] Following a theoretical study of a heterovariband GaAlAs photocell as spectral analog of the eye, an optimum such device with a quantum efficiency spectrum most closely approximating the eye sensitivity spectrum was developed experimentally in two steps. First trial specimens of heterovariband GaAlAs structures were produced and the four essential parameters (two threshold energy levels for direct optical transitions in the narrow-variband n-region and in the homo-wideband p-region respectively, optical thickness of the p-region at the threshold energy level, band variation index) were varied for achieving closest possible conformance to the theoretical 12-parameter model, the major but not at all critical deviation from the latter remaining the nonrectilinearity of bands in real structures. Next were determined, on the basis of measurements, the values of those four parameters making the

quantum efficiency spectrum of the photocell deviate minimally from the eye sensitivity spectrum at room temperature. Specimens of GaAlAs p-n structures were deposited on n-GaAs substrates by liquid-phase epitaxy from a solution melt. On top of the substrate were successively grown, by cooling and doping, a 0.002-0.003 mm thick variband n-GaAs;Sn layer, a 0.003-0.004 mm thick wideband p-GaAlAs;Zn layer, and a p-GaAs;Ge contact layer. A large part of the contact layer was subsequently removed by selective etching so as to expose a large photosensitive p-GaAlAs window. Coating this window with a clear film by anodizing reduced the reflection coefficient at its surface to 0.05 for the maximum-sensitivity wavelength and to 0.20-0.15 for the wavelengths at the two edges of the spectrum. Two structures were selected as most promising for optimization. The resulting optimum photocell had the following characteristics: a 1.90 eV threshold energy for direct optical transitions at the heterojunction in the variband n-region, an approximately 700 eV/cm gradient of gap energy equal to the gradient of transition threshold energy in the variband n-region, a 2.41 eV threshold energy for direct optical transitions in the illuminated wideband p-region, and a 0.003 mm thick wideband p-region with a characteristic absorption coefficient of  $3 \times 10^3 \text{ cm}^{-1}$ . The authors thank O. V. Konstantinov and V. Ye. Chelnokov for discussing the results. Figures 2; tables 2; references 4: 2 Russian, 2 Western.



UDC 621.3.049.77

**Small-Signal Amplifier Micropacks**  
**M2USE0081A/B and M2USE0082A/B**  
*18600017d Moscow PRIBORY I SISTEMY*  
*UPRAVLENIYA in Russian No 6, Jun 88 pp 31-33*

[Article by V. F. Levental, engineer, T. S. Popova, engineer, and V. V. Tatsenko, engineer]

[Abstract] Four differential-amplifier micropacks have been developed by the Scientific-Industrial Association "Electron Devices" in Yaroslavl for normalization and preamplification of small signal from various transducers such as thermo-couples and strain gages: M2USE0081A, M2USE0081B, M2USE0082A,

M2USE0082B. Their design is that of a conventional instrument amplifier based on three operational amplifiers, high-precision ones being used so as to minimize the temperature drift of the bias voltage. They are produced by the thin-film technology, with unclad active elements in a 1210.28-2 metal-glass enclosure. They differ in noise level, length of output voltage stabilization time, and mean temperature drift of bias voltage. Their gain can be set at 200 or at 10,000. They can withstand vibrations over the 10-500 Hz frequency range with acceleration up to  $100 \text{ m/s}^2$ , repeated shocks of 2-6 ms duration with acceleration up to  $750 \text{ m/s}^2$ , and continuous centrifugal loads with linear acceleration up to  $200 \text{ m/s}^2$ . They are moisture-proof in air at  $25^\circ\text{C}$  and 98 percent relative humidity. Figures 5; tables 2; references 2: 1 Russian, 1 Western (in Russian translation).

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